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THE WORK OF THE NAVAL REPAIR SHIP VULCAN.

By Gardiner C. Sims and Wm. S. Aldrich.

THE abandonment of sails and the universal introduction of steam engines for the propulsion of naval vessels have wrought great changes in naval economics. Vast steam motive powers and a multitude of auxiliary machines are all to be kept in a state of readiness for service and of efficiency of operation. The maintenance and repair of such varied mechanisms of a modern war vessel are ever pressing questions with the commanding officer, even in the piping times of peace. In the storm and stress of war, however, the whole life of the naval service is more complex, its requirements more exacting. Readiness for action and efficiency of service become most imperative demands.

Vessels cannot resort to naval stations whenever supplies and repairs are needed in war time. Some provision must be made to supply the lack of navy-yard facilities. "No one can understand the value of such an adjunct who has not had to look around for ships to go on duty, the long list of waiters for repairs or overhauling was sometimes heartbreaking; a full third of such a fleet as ours had at all times been counted off as unavailable for such reasons and others." Thus writes Capt. F. E. Chadwick, U. S. N., the Commanding Officer of Admiral Sampson's flagship.

The performance of the battle-ship Oregon, in view of these facts, becomes still more remarkable. Such a record would seem to controvert the necessity for naval repair ships. Fourteen thousand five hundred miles from the Pacific to the Atlantic, on blockade duty off Santiago, actively engaging Cervera's fleet and chasing the Colon,

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all without any repairs to the motive-power machinery other than those usually executed on board the Oregon,—will go down into history as a feat unparalleled in the annals of naval engineering.

The engineer in all branches of his profession is a true economist. Anticipating the unexpected he diligently prepares such measures as shall prevent the unexpected from happening. Before the late war, the Engineer-in-Chief of the Navy, Rear Admiral George W. Melville, U. S. N., brought to the attention of the Secretary of the Navy, "the desirability of making such preparation for the fitting out of a vessel which would be a floating repair shop as would enable the work to be done with great rapidity when needed."

Scarcely had war been declared when active preparations were made to carry out this recommendation. The steamship Chatham, of the Merchants & Miners Transportation Co., was purchased by the Government, sent to the Boston Navy Yard, overhauled, fitted out, renamed Vulcan, placed in commission May 22, sailed for Cuba, June 22, reported to Admiral Sampson, off Santiago, on the morning of July 1, and was ordered to the naval base, Guantánamo Bay, thirty-six miles to the eastward. Here the Vulcan came to anchor, in the afternoon of the same day, and entered at once upon her long career, as a repair ship for the fleet.

Fitted out with the most approved workshop appliances, with a large and varied assortment of engineers' and ship's stores, and a picked complement of skilled mechanics, the Vulcan was pre-eminently an "engineer's ship." The project was in no sense an experiment. Had it been looked upon as such, it passed beyond the experimental stage in less than twenty-four hours after reporting for duty to Admiral Sampson.

The first requisition for repairs came abroad while off Santiago. It was from the torpedo-boat Ericsson, for a pair of new brass tappets for valve stem of steam pump. As soon as the Vulcan came to anchor in Guantánamo Bay she was pressed into service for an unusually large amount of all conceivable kinds of repair work. Many of the ships evidently had been expecting her arrival much earlier. The work awaiting repairs had so far accumulated that the Vulcan's force, in three shifts, was kept steadily at it, night and day. Two days later came the news of Cervera's *sortie* and the utter destruction of his fleet. It seemed to spur the men on to still greater exertion, culminating in the preparation of the Eastern and Covering Squadrons for the coast of Spain. These chosen vessels of Admiral Sampson's fleet were overhauled and fitted out by the

Vulcan, single-handed and alone, more than two thousand miles from a navy yard, and reported ready to set sail for Spain. The result was the signing of the protocol, August 12th.

The Chatham, now the Vulcan, was the sister ship of the Berkshire, built by the American Ship Building Co., of Philadelphia, in 1884. She was well designed, strongly built, and for years had been a credit to the early work of this company. The original interior arrangements seemed to be particularly adapted to meet the requirements of her new line of service in the auxiliary navy. On each deck were ample gangways, on each side of the engine house, and large cargo ports on each side, two forward and two aft. These gangways greatly facilitated supervision, and permitted of an extension of the shop work from stem to stern, all on one deck, to be fitted up and thereafter known as the "shop deck." The cargo ports admitted much needed light and fresh air; and from steam launches and ship's boats, supplies and repair work were received and delivered through these ports, at about two feet above the load water line.

From the standpoint of equipment, the key to the Vulcan's success as a floating repair shop is to be seen in the selection and

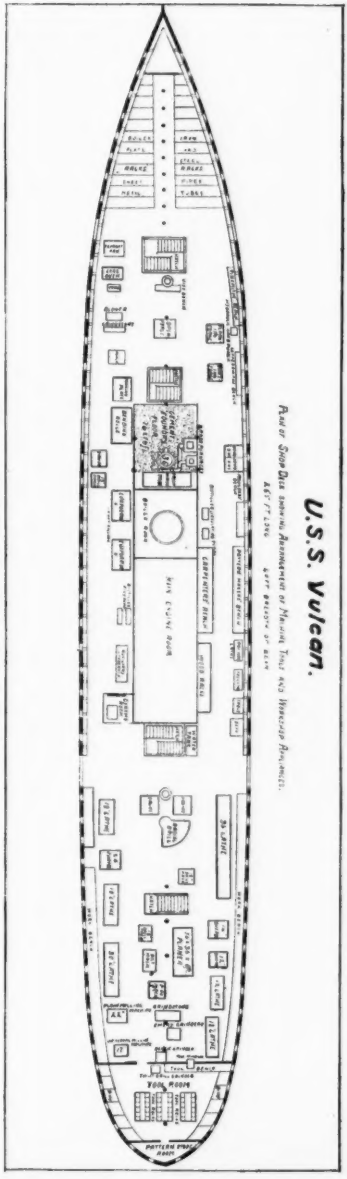


FIG. 1. PLAN OF SHOP DECK, U. S. S. VULCAN.

the arrangement of the machinery on the shop deck. No method of arranging shops on shore would apply at sea. No convenient wings, ells, or tees could be run off from a central shop system. No gallery plan could be adopted. The fore-and-aft arrangement of everything was necessitated by the rigid requirements of having all work on deck, as near the water's edge as possible, facilitating receipt, execution and discharge of work, with convenience of supervision, giving ready command of the whole work of the shops.

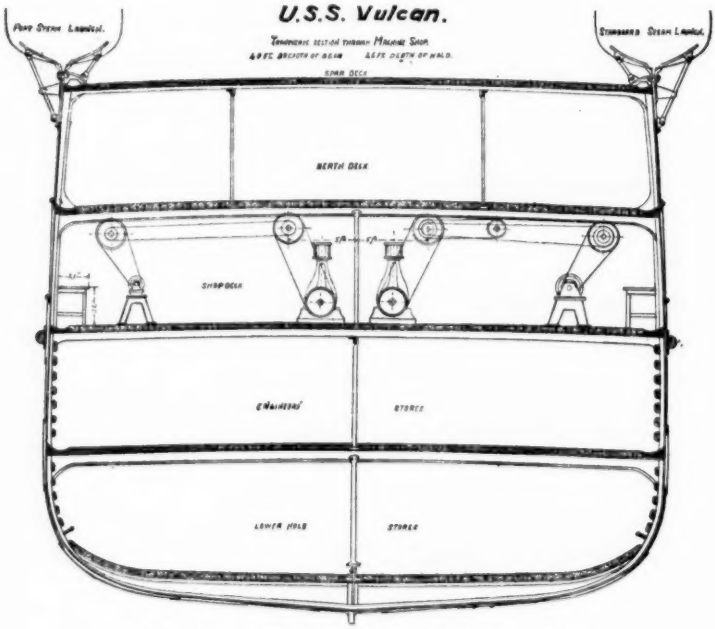


FIG. 2. TRANSVERSE SECTION THROUGH MACHINE SHOP.

The final arrangement of the shop deck is shown in Fig. 1. Racks for pipes, bar stock, sheet metal and plates extended about forty feet forward from the fore hatch. The boiler, forging, brazing, and foundry work were provided for in the vicinity of the forward cargo ports, for light and ventilation, occupying about fifty feet of the space between the engine house and the foremast. The pattern shop and the distilling plant were placed in the starboard and port gangways respectively, amidships of the engine house.

The administrative centre of the shop deck, so to speak, the superintendent's office and the foreman's headquarters, or in naval parlance, the headquarters of the officer in charge and of the officer of the day, were located by the starboard cargo port, abreast of the mainmast. Fig. 12 shows a view of the machine shop, from this point, looking aft. The machine shop extended about fifty feet aft of the mainmast to the tool-room, from the delivery window of which the view shown in Fig. 13 was taken, looking forward. Work benches were placed in the tool-room and on each side throughout the whole length of the machine shop, outboard of the machines, as well as along the pattern shop and brazing forge.

The three steam engines driving the shop machinery were of the simple, single-cylinder vertical-inverted plain slide-valve type, and were located as shown in Figs. 1 and 2.

TABLE OF SIZES AND POWERS OF SHOP ENGINES OF THE VULCAN.

Where located.	Size of Cylinder.	Horse Power	Diam. of Wheel.	Shafting Diam.	Driven Revs.
Machine Shop Starboard	9 x 9	20	36	2 7-16	200
Machine Shop Port	7½ x 8	12	36	2 3-16	225
Boiler Shop.	7 x 7	10	30	2 3-16	250

All main-line shafting was run fore and aft. Throughout the length of the machine shop, two lines were extended, five feet each from the centre line of the ship, and parallel to it. Similar lines of shafting were extended forward on the starboard and port sides of the engine-room house, and driven from the machine-shop lines respectively. To obtain as great a length of belt as possible, the counter-shafts were carried well outboard; and connected to the machines with oblique belts. The same feature will be seen in Fig. 2, with regard to the main driving-belt of the shop engines.

The head room was 7½ feet between the shop deck and the deck beams above. Belts from line to counter-shafts and all other athwartship belts were in the way of standing erect under them, but did not seriously interfere otherwise with working the machine tools. This available head room below belting varied somewhat according to circumstances, but the projecting adjusting screws of the hangers proved much more exasperating. Officers and men, however, became accustomed to dodging both.

The installation of the forge blower and hot-air exhaust system is shown in Fig. 3. The former was a "Monogram" Sturtevant blower, with 7-inch discharge driven from the forward line of

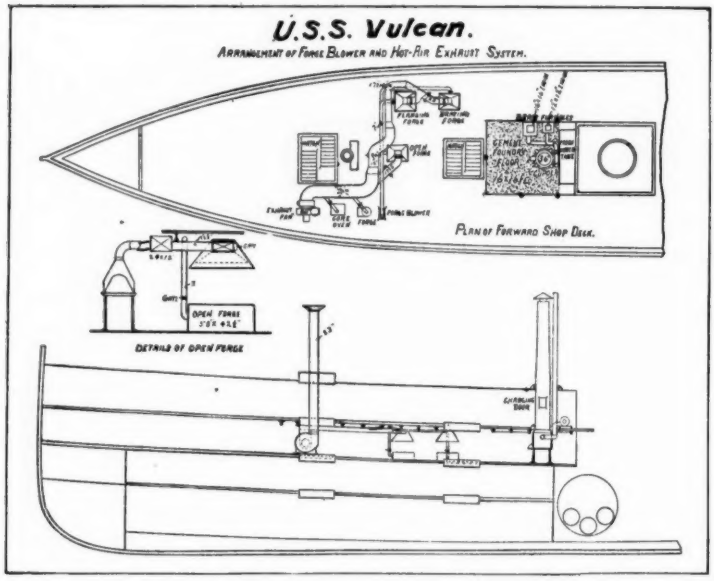


FIG. 3. ARRANGEMENT OF BLOWER AND EXHAUST SYSTEM.

shafting; and the latter was equipped with a standard Sturtevant exhaust fan, with 23-inch discharge, and driven by 3″ x 4½″ engine. New England mechanics, working nine hours a day, 'tween decks, off the south coast of Cuba, in mid-summer, required all the fresh water and air they could get. The next best thing to the forced circulation of fresh air was to have all of the foul air and smoke from the forge fires exhausted, and this arrangement proved of inestimable value.

A foundry at sea had not been heard of before the cruise of the Vulcan. Whatever other kinds of naval repair work had been executed heretofore on board ship, that of making large brass and iron castings had not been attempted. In her facilities for this new line of work the Vulcan stands preëminent and alone. That the unique equipment for foundry work was successful is more than shown by the fact that thousands of pounds of iron and brass castings were made and finished for the ships of the fleet. The brass furnaces were kept in almost constant service, sometimes running off two heats a day, and making it necessary to carry the work far

into the night, much to the discomfort of the men, who were trying to get some sleep and rest before another day's work. In iron casting not more than one heat was run off in a day and that usually about 3 o'clock in the afternoon. For after filling the moulds and dropping bottom, it was practically impossible to do much more in that part of the ship till the next morning. Kipling has sung for the Scotch engineer and stoker, but there was no heaven-born genius on board the Vulcan to treasure up the memories and scenes incident to dropping bottom. The usual luxuries of such work ashore were entirely missing. Like the fiery furnace of old, the heat seemed seven times more intense than it was wont to be ashore.

The foundry floor was made by cutting away the three-inch wood planks of the shop deck to the steel deck-plates below, laying down one-half inch asbestos board and then filling in to the original level of the deck with concrete, mixed in the proportion of one part of Portland cement to one and one-half of sand. Directly beneath the cupola a fire-brick floor was laid in cement on the asbestos board, and a cast iron foot piece placed in the center to receive the bearing bar of the cupola bottom. It was rarely possible to get all of the flasks on such of the space as might be available of this

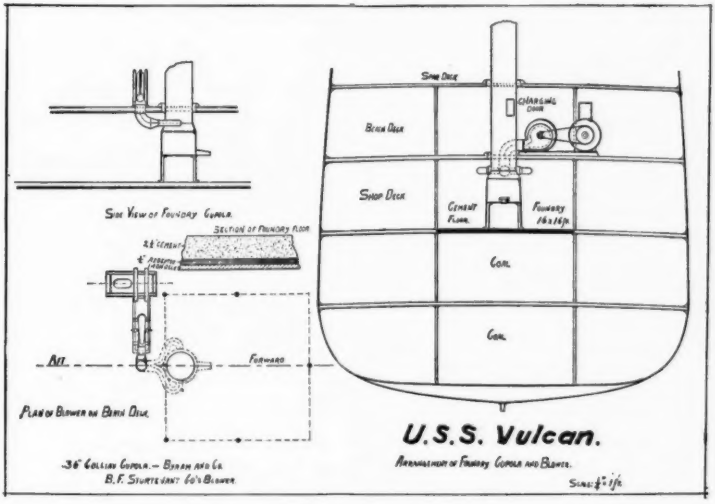


FIG. 4. ARRANGEMENT OF FOUNDRY CUPOLA AND BLOWER.

16 x 16 foot foundry floor. Many of the moulds had to be poured on the wood deck surrounding it, a liberal supply of water and of wet sand being kept in readiness for any emergency.

The cupola had a melting capacity of from 3,000 to 4,000 pounds of iron at one heat, or a rated daily capacity of five tons, being 27 inches inside diameter. It was charged from the deck above the foundry floor, as shown in Fig. 8. In the same view will be seen the No. 5 Sturtevant cupola blower, supplying an air blast through 9¾-inch discharge pipe, of from 4 to 12 ounces pressure, according to circumstances. The time required to blow up for a heat was usually about forty-five minutes, from turning on the melting blast till pouring ceased. Whenever the cupola was operated fire pumps were kept running, and men stationed at the fire mains with hose and buckets ready for any emergency. On the spar deck and topsides bucket men were also stationed, to guard woodwork, rigging, sailcloth, etc., from the sparks of the cupola blast.

There were two brass furnaces, 12″ x 12″ and 16″ x 16″, inside lining, respectively, located on the foundry floor, on the starboard side of the cupola, as shown in Fig. 9. They had each a separate stack, placed aft of the cupola and extending a short distance above it. The total height of all of these stacks was about 33 feet above the foundry floor.

The intense heat from the brass furnaces and stacks, and from directly over the cupola tap hole, proved the most difficult problem with which we had to deal in this part of the Vulcan's equipment. The whole wooden deck above the brass furnaces and the foundry floor was protected by asbestos board, overlaid with tin. Sheet iron was placed between the deck-beams above the tap hole, giving about eight inches of clear space between it and the wooden deck above for the free circulation of air.

A heavy covering of asbestos was placed around the brass furnaces and the foundry cupola. In the latter case it was extended from the bottom of the 37-inch shell of the cupola to the topsides of the ship. The stacks of the brass furnaces were lined with cylindrical fire-clay pipe, with cemented joints throughout their whole length. Free circulation of air was allowed around all of these stacks by cutting away the wooden decks and fitting with ample coamings. This proved entirely satisfactory for the cupola. It was found necessary, however, to open up more and more the air space around the brass furnace stacks. The horizontal and inclined portions of these stacks, just below the berth deck, were

provided with heavy asbestos coverings to further protect this deck from the excessive radiation of heat.

The engineers' stores comprised the finest and largest assortment ever put aboard a naval vessel, having been selected with great care for the specific work of the Vulcan as a repair and supply ship. They were placed below the shop deck, in specially-arranged store-rooms and bins, accessible from the after hatch and from that provided in the centre of the machine shop. The pig iron, anthracite coal, heavier stock of iron and steel stores, and

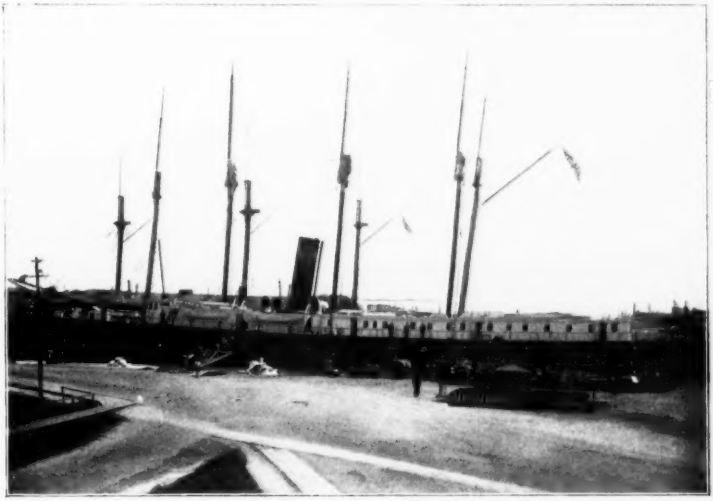


FIG. 5. U. S. S. VULCAN FITTING OUT AT BOSTON NAVY YARD.

barrels of oil were stowed in the lower hold aft. The fore part of the ship, below the shop deck, was also specially fitted out for engineers' and ship's stores, and for carrying increased coal supply.

Incandescent lamps were fitted throughout, in store rooms and on the shop deck, in addition to those which had been originally installed, and arranged to suit the conditions of the work. Three long-burning enclosed arc lamps were placed in the machine shops. With glaring forge fires and brilliant arc and incandescent lights, we were no doubt nightly exposing ourselves to Spanish Mausers off in the mountain passes and lying low in the rifle pits around the shores of Guantánamo Bay. The first night of our work we were ordered to put out all lights. It soon became apparent that the

FIG. 6. U. S. S. VULCAN IN DRY DOCK AT BOSTON NAVY YARD.

Vulcan would never get through with the work unless allowed to work at night.

The distilling plant was located forward, as shown in Fig. 1, and had a capacity of 10,000 gallons of fresh water daily. The

value of this at such a time and in such a climate, with skilled mechanics required to perform the work of the Vulcan nine hours a day 'tween decks, can not be over estimated. We were not only able to supply ourselves at all times with this commodity, but frequently gave large supplies of distilled water to the United States Marines, on Camp McCalla, as well as to ship's crews coming into the harbor for this and other supplies.

The examination and enlistment of skilled mechanics, to serve for one year, progressed rapidly while the Vulcan was fitting out at the Boston Navy Yard. Their highest rating was that of Chief Machinist, paying $75.00 monthly, with an allowance for rations of $9.00 monthly. Almost all of these men were quartered in the staterooms on the spar deck and in a portion of the original saloon of the steamship Chatham. Other enlisted machinists and workmen of lower rating than Chief swung in hammocks on the berth deck with the ship's crew. All of the men from Massachusetts received, in common with other volunteers from the same state, an additional sum of $7.00 monthly during their term of service.

Work in the navy yard was at once organized for the newly-enlisted men, as seemed best adapted to bring out their several abilities, and in the various shops, according to the work required for the Vulcan. This served a double purpose—the work of fitting out was greatly facilitated, and we learned to a certain

By courtesy of Collier's Weekly.

FIG. 7. U. S. S. VULCAN WITH FLEET AT ANCHOR IN GUANTANAMO BAY.

extent, before setting sail, what to expect of the men. The personnel of the working force of such a ship was a vitally-important question. The men enlisted from all conceivable motives. Few had ever been to sea before. Probably not one had ever been engaged in naval repairs at sea. Scarcely any of them knew their own resourcefulness till it was put to the test, a thousand miles from their typical New England workshops and quiet homes. With characteristic American genius they early adapted themselves to the new environment, took hold of the work with a will, were anxious to make things go, and were withal ambitious to excel. The great majority of the Vulcan's volunteers were in for whatever might be ahead. They had enlisted for better or for worse; had left happy homes and better paying positions; and were fired with an enthusiasm born only of love of home and native land. They enlisted neither to shoot nor to be shot. Non-combatants in the strictest sense of the word their work was to be wholly constructive rather than destructive. It would have dispelled the hopes of perhaps a few had they known that they were not going on a summer pleasure cruise, or were little likely to have a picnic—that in fact

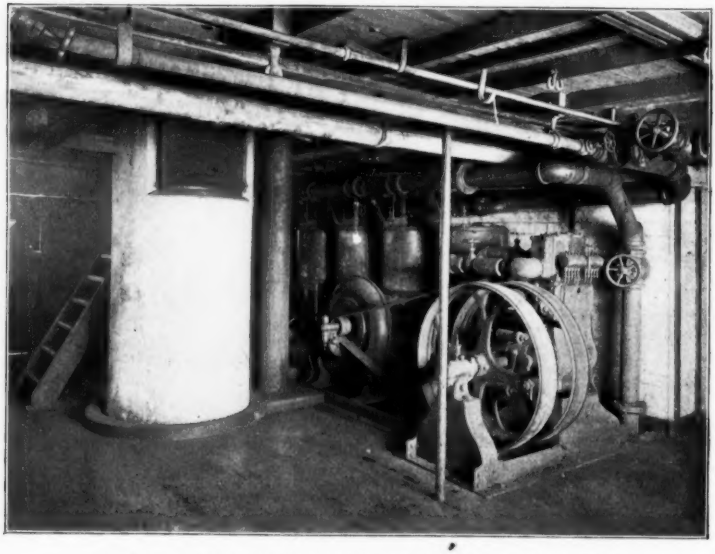


FIG. 8. VIEW OF FOUNDRY CUPOLA AND BLOWER ON BERTH DECK.

there would be four months of the hardest kind of work ahead of them, riding at anchor in Guantánamo Bay.

The enlisted men of the shop force were of the most varied attainments. Among them were graduates from colleges and technical schools, doctors, dentists, engineers, machinists, skilled and unskilled workmen from all the walks and stations of life, equal in such a representative capacity to the Rough Riders ashore. It was singularly fortunate that some of them were of such abilities as to adapt them to quite a wide range of most helpful service in executing the work of the Vulcan's program.

After many days we had learned by experience the specialties of all of the men. Only then was it possible to assign them to work and duties for which they were more or less thoroughly adapted. The following classification is not according to navy enlistment papers of these men, but according to their several abilities as determined after two months' experience with them:

Machinists,	39	with	11	helpers.
Boilermakers,	25	"	2	"
Blacksmiths,	5	"	2	"
Coppersmiths,	5	"	1	"
Pipe-fitters,	4	"	3	"
Moulders,	4	"	1	"
Electrical Machinists,	2			
Pattern-makers,	3			
Carpenters,	2			

Summary: Workshop force,	89	with 20 helpers,	109
Engine and Fire-room detail,			30
Engineers' Yeomen,			2
Cooks,			7
Ship's Crew of the Vulcan,			70
Total,			218

A ship fitted out at a navy yard, it has been said, is never ready for sea, and the Vulcan was less likely to be an exception to the rule than any other vessel of the auxiliary navy. It was like fitting up and starting a new manufacturing establishment. A hundred things seemed to demand attention at the last moment. But the day and hour were fixed, perhaps with a divine prescience, but with a certainty that as the long days of June wore on it became more and more probable that Cervera would try to make his escape. As it was, the Vulcan reported to Admiral Sampson just forty-eight hours before the famous *sortie*.

At sea, a part of the shop force was divided into three watches, similar to that of the engine room detail, and the remainder was assigned to the regular deck watches. Throughout the twenty-

four hours work was carried on in the shops and store rooms of the Vulcan, to finish the many little details of interior fittings and arrangements, and systematize everything for the first call to duty. If anything in the late war anticipated the new Navy Personnel Bill, among the enlisted men, this manning of the Vulcan at sea seemed to foreshadow it. All hands had something to do, and they did it, with an adaptation and a resourcefulness truly characteristic of the American mechanic.

The Vulcan arrived off Santiago de Cuba just in time to witness the operations along the shore of Aguadores, three miles east of Morro Castle. General Shafter's line of investment extended from Aguadores to El Caney, forming a battle line about six miles long. At Aguadores the Spaniards held the old stone fort near the western end of the railroad bridge, which they had wrecked earlier. General Bates held the extreme left of the line of investment, terminating at the signal house at the eastern end of the railroad bridge. The 33d Michigan, under General Duffield, had just arrived on the Harvard, the convoy of the Vulcan from Newport News. They were landed at Altares and brought to the front along the shore by the

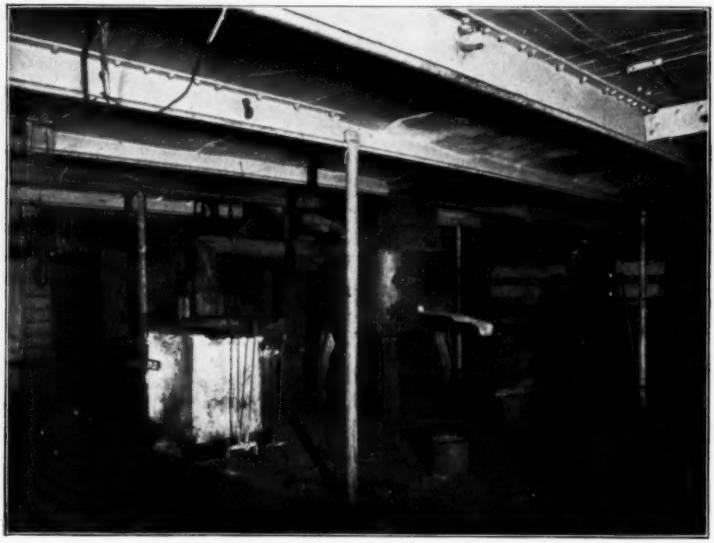


FIG. 9. VIEW OF FOUNDRY EQUIPMENT ON SHOP DECK.

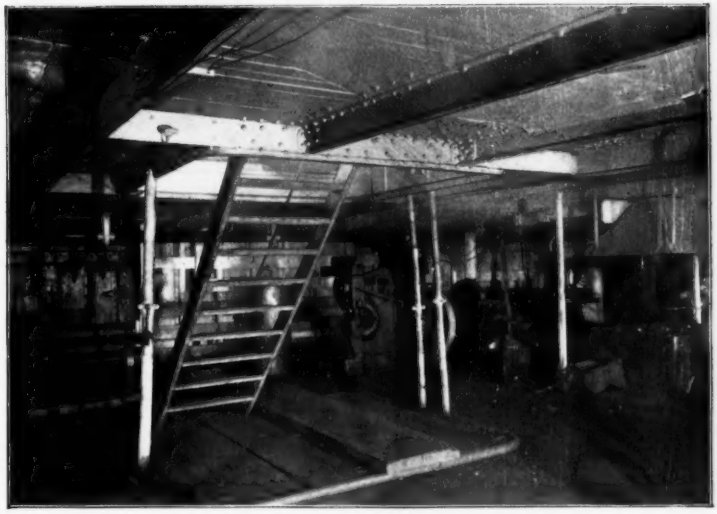


FIG 10. BOILER SHOP AND FORGE DEPARTMENT.
View looking toward port bow.

line of the railroad, advancing toward the bridge under cover of the fire from Admiral Sampson's flagship, and the gunboats, Suwanee and Gloucester. Three shots at the old stone fort were requested and allowed the Suwanee. The first, tore the Spanish flag; the second, struck the flagstaff; the third, shot away the staff and the flag, and exploding scattered the Spaniards in all directions, and demolished the old fortification, sending its ruins rolling down the embankment like a landslide.

There were two six-pounders forward, and we tendered our services to Admiral Sampson. He reminded us that gunboats and battleships would do the fighting, if there was any to be done, while our sphere of activity was elsewhere. After reporting to the Admiral the Vulcan stood towards the shore, almost under the brow of Morro, so close, in fact, that the Admiral signalled the Massachusetts to bespeak the Vulcan as she rounded to, to keep farther off shore. The Vulcan changed her course, bespoke Captain Philip, of the Texas, as he was wetting down decks and clearing ship for action, and returning farther out to sea, bespoke the Newark, and left the scene of action for Guantánamo Bay. This was the first, the last, the only smoke of battle enjoyed by the Vulcan.

Guantánamo Bay possessed every advantage for a naval base, almost land-locked, with broad and deep channels, shoal waters for smaller vessels, good beaches for bathing and for landing parties, fine fishing, and an inexhaustible supply of fresh water from the Guantánamo River, navigable for fourteen miles, and emptying near the mouth of the bay.

The cable from Caimanera to Mole St. Nicholas was early cut by the Americans at a point between Caimanera and the "Playa," or the cable station at Fisherman's Point. Having established Guantánamo Bay as a naval base, the government made use of this cable station for all dispatches. It was equally used by the newspaper correspondents, but at times, of course, was completely cut off from such use. In the evening of July 3, for instance, Washington was receiving army dispatches of quite recent events about Santiago and the correspondents could not avail themselves of this cable for news to the States as to the disposition of Cervera's fleet. The cable was repaired later on and government messages thereafter sent from Caimanera. The Vulcan afforded facilities to the cable staff in the electrical work of repairing the cable. The cable house is built of corrugated iron, lined with wood, with two shot holes for ventilation and sight seeing—

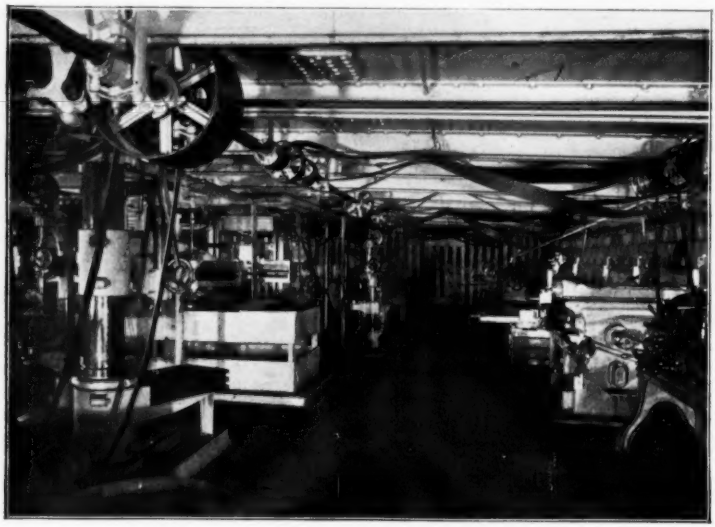


FIG. 11. MACHINE SHOP. PORT SIDE, LOOKING AFT.

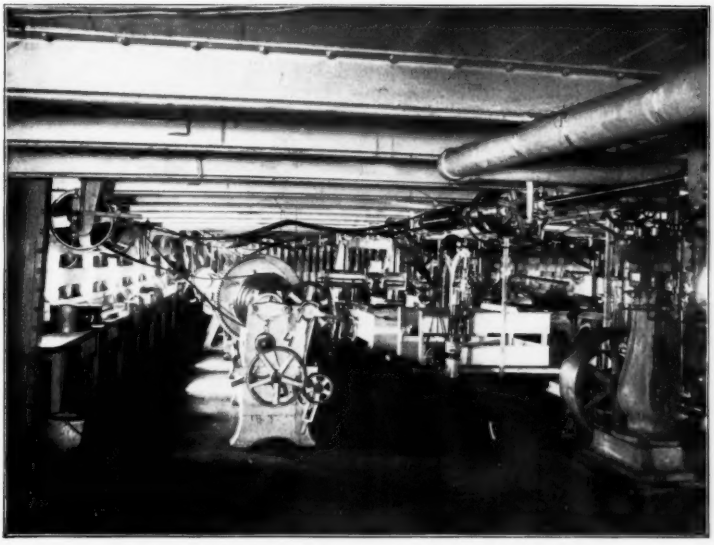


FIG. 12. MACHINE SHOP. STARBOARD SIDE, LOOKING AFT.

souvenirs of the struggle in establishing this point as a naval base, June 10-12, 1898. To the rear of it are the remains of an old-time Spanish homestead, with walks and orchards of palms laid out with taste.

The division of the working force into three shifts was maintained only so long as it was absolutely necessary in order that the early rush of work might not accumulate. Those men who were obliged to rest and to sleep at night could get very little of either on account of the noise and the lights. Those obliged to sleep in the daytime fared no better, with noise and disturbances on every hand. The conditions surrounding the men on board the Vulcan were as different from those on a regular naval vessel as could well be imagined. Of course, the work goes on, but long lines of shop shafting, blowers, and hot forges with the accompanying noises of work in forging, boilermaking and machine shop, are not kept in full operation seven days of the week throughout the twenty-four hours. There was no place for the men to rest—no rendezvous, such as they had been accustomed to on shore. The work was continuous, for eight or nine hours, or more, as necessity demanded,—quite different from the customary four hours on duty and

eight hours off in the regular service. As soon as possible, therefore, the men were divided into two shifts, giving all hands eight hours of rest and quietness.

The regular day's work of nine hours was established as soon as possible, from 6:45 to 11:45 A. M., and from 12:45 to 4:45 P. M. The fifteen minutes was allowed at the close of each period to give the men time to wash up and get ready for the next meal, set for the even hour, as usual on board ship. The men were called at 4:30 or 5:00 A. M., according to the season, giving ample time to

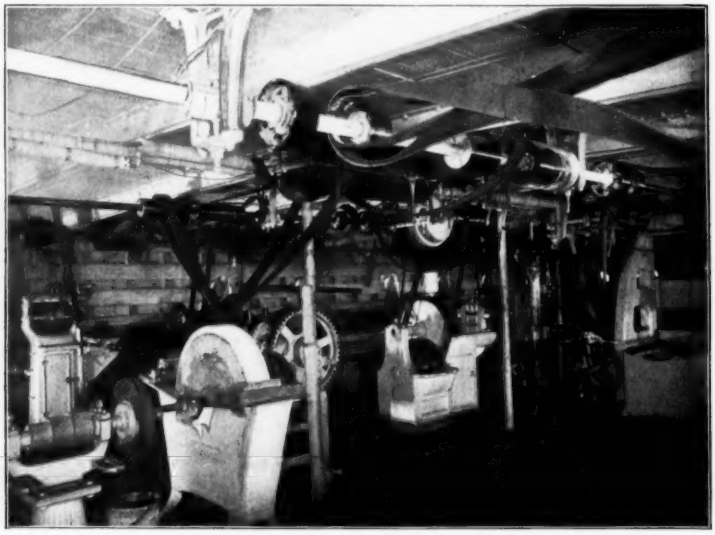


FIG. 13. MACHINE SHOP. STARBOARD SIDE, LOOKING FORWARD FROM TOOL ROOM.

wash all clothes, prepare their quarters and staterooms for the daily inspection at 9:00 A. M., and engage in other early morning work of a naval vessel. All hands were called to quarters, at 6:00 P. M., daily, except Sundays, and "taps" were sounded at 9:00 P. M. Fire drills and "abandon ship" were occasional exercises.

All orders for repairs or supplies were received at the starboard gangway, with the accompanying requisition, after being approved by the commanding officer of the Vulcan, Lieutenant-Commander Ira Harris, U. S. N., and endorsed "O.K.," by Chief-Engineer James H. Chasmar, U. S. N.

Shop orders were written out for the repairs or the supplies and sent to the heads or chiefs of the respective shops, according to the kind of work called for. These orders were returned with the finished work, to the shop headquarters, with the workman's time noted thereon when required. Entries were made of the same, and the work delivered from the port gangway. A daily journal was kept of the character and extent of all repair work.

Assignments to duty were made each morning and noon hour, in the case of men not otherwise detailed, or such as might be

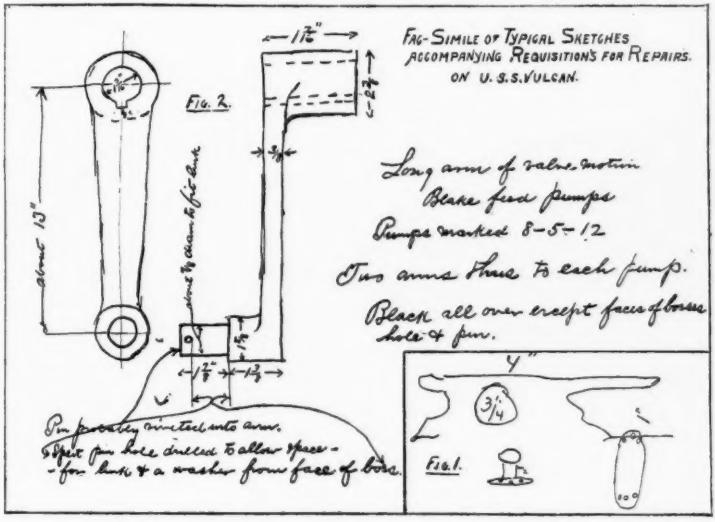

Fac-Simile of Typical Sketches accompanying Requisitions for Repairs. on U. S. S. Vulcan.
Fig. 2.
Long arms of valve motion Blake feed pumps
Pumps marked 8-5-12
Two arms these to each pump.
Black all over except faces of brass bush & pin.
Fig. 1.

FIG. 14. FAC-SIMILE OF TYPICAL SKETCHES ACCOMPANYING REQUISITIONS FOR REPAIRS.

required to leave the Vulcan for work on other ships. Steam launches took the latter parties, at 7:00 A. M. and 1:00 P. M., and called for them again in time to return for meals on board the Vulcan.

All tools required by the workmen, either for use on board the Vulcan or some other ship were delivered from the tool room, on the workman's request, and his signing for them. All stock and material which workmen might require were delivered from the store rooms only on written order and requisition of an officer, usually on the order of the engineer officer on duty on the machine shop desk.

Sketches accompanying requisition were sometimes very meagre, while others were detailed enough to gratify the most fastidious mechanic. The productions, shown in Fig. 14, represent two types of drawings, sufficiently far apart in merit and usefulness to include almost all of the other kinds between these extremes. In a few instances, however, blue prints and carefully executed pen-and-ink drawings were furnished with the requisitions for repairs.

The group of patterns, Fig. 15, is thoroughly representative of the wide range of work called for in the line of brass castings.

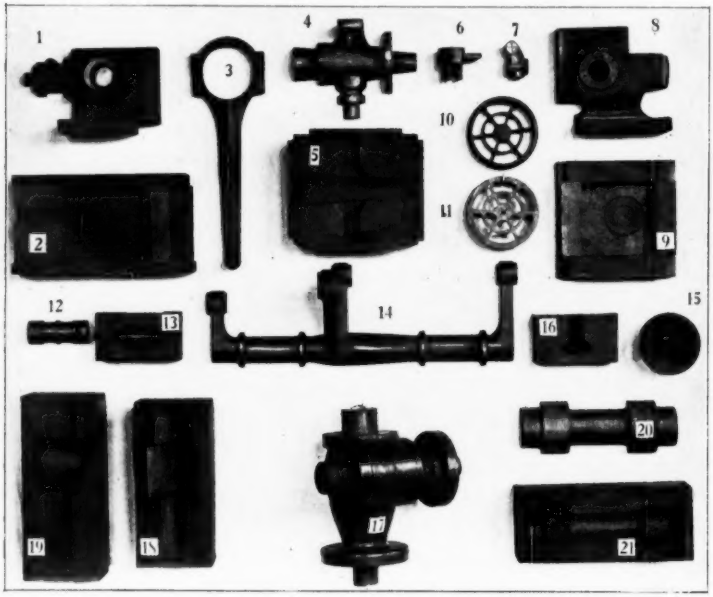
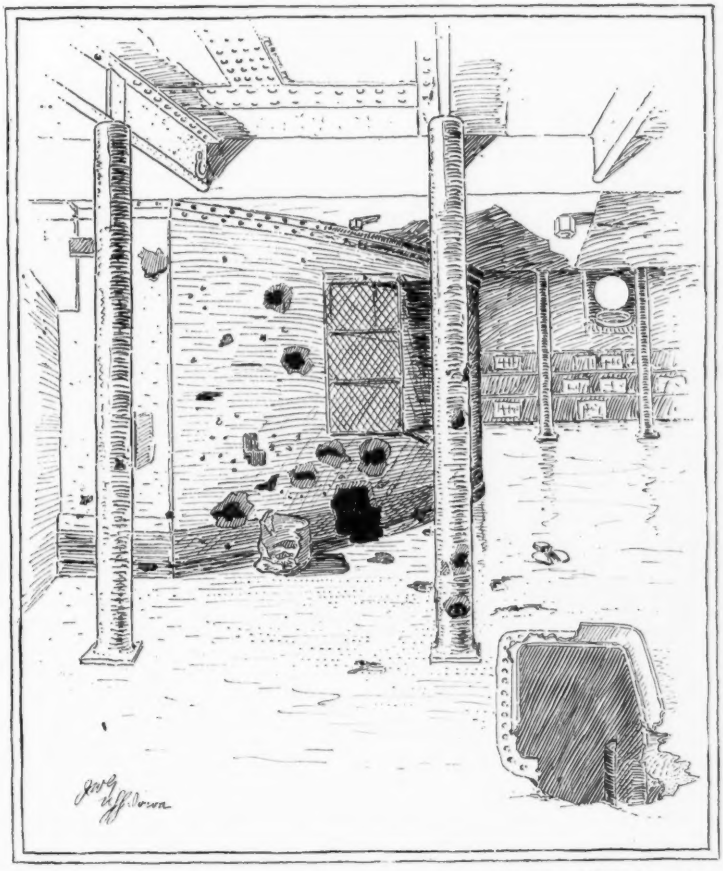


FIG. 15. GROUP OF TYPICAL PATTERNS FOR CASTINGS AND REPAIR WORK FINISHED ON BOARD THE U. S. S. VULCAN.

1, 2; Pattern and Core Box for Crosshead of Ice Machine, U. S. S. New York. 3; Pattern for Eccentric Rod and Strap for Willan's Dynamo Engine, U. S. S. Gloucester. 4, 5; Pattern and Core Box for Plug Cock, for U. S. S Oregon. 6; Pattern for a small valve, to be fitted with loose stem, representative of large class of repair work. 7; Pattern for Rod Clip of Auxiliary Pump, U. S. Torpedo Boat Rodgers. 8, 9; Pattern and Core Box for Dynamo Engine, U. S. S. Massachusetts 10 11; Wood and Metal Pattern for Valve Seats, U. S.S. New York. 12, 13; Pattern and Core Box for Supplementary Steam Valve, for Auxiliary Pump, U. S. S. Indiana. 14; Pattern for Rock Shaft for U. S. S Helena 15. 16; Pattern and Core Box for Valve, for U. S. S. Newark. 17, 18, 19; Pattern and Core Box for Double Valve, for U. S. S. Vixen. 20, 21; Pattern and Core Box for Hydraulic Piston, for U. S. S. Indiana.



By courtesy of McClure's Magazine.

FIG. 16.—THE DAMAGED ARMOR HATCH OF U. S. S. IOWA.
Repaired by U. S. S. Vulcan.

Perhaps they illustrate methods of pattern-making and seem to dictate moulding practice slightly at variance with established rules, but the conditions under which they were rushed through must be kept in mind. The core boxes seem to show rough-and-ready construction, but these had to be at hand when the patterns were finished. The pattern and core boxes for the double-valve of the Vixen, (17, 18, 19), for instance, were made at one stretch, without

rest or sleep for the pattern-makers, till all was ready to hand over to the moulder.

The pattern for the valve-seats for the New York, (10, 11) was made from a carefully-executed pencil sketch, furnished the Vulcan. The pattern for the rock-shaft for the Helena (14) was made from a blue print, also furnished for the purpose. All of the other patterns shown in Fig. 15 were made from the original articles sent aboard the Vulcan as samples, and this was the usual practice followed in making patterns for such new parts.

White-metal patterns were made frequently from the first wood pattern, when several spare parts were ordered. This is shown in the case of valve-seats for the New York (10, 11), of which a requisition for thirty-six was filled. The requisition for the plug cocks for the Oregon (4, 5), called for nine castings only, to be afterwards finished by the machinists of the Oregon in their own shops; and these were not to replace any broken parts. A six-inch Spanish shell had penetrated the Iowa, on the starboard bow, a little above the water line, and exploded about 12 feet inboard, where it struck an armor hatch on the berth deck. Fig. 16 shows the erratic course of the fragments. There were at least three hundred holes in the thin steel deck and bulkheads in the vicinity of the explosion. Fragments of the shell passed through, as the armor hatch was blown off, and started a fire on the protective deck below. The Vulcan made an entirely new hatch cover and coaming with all fastenings, and trimmed around the ragged edge of the deck, and inserted a new piece of plate.

Submarine mines were quite thickly located in the upper portion of Guantánamo Bay between Caimanera and the fort opposite. Launches from the Marblehead and Dolphin began searching these upper channels, and finally thirty-nine were removed and safely placed on the adjoining shores and beneath the old fortification opposite Caimanera. The Texas struck one, and took it aboard as a trophy. These mines were put down recently, some of them as late as April, 1898. All of them were contact mines, but none were in perfect order, as they were repeatedly struck by the propeller blades of the Texas and Marblehead. It requires 40 pounds pressure to explode the cap upon which the firing pins are pressed by the contact hooks, of which there are six. In the one brought aboard the Vulcan and taken apart, the charge consisted of 117 pounds of wet guncotton. These mines are about 30 inches across the top and 36 inches high, built of light boiler plate, and

having the charge of guncotton in a cylinder of 12 inches diameter.

The furnaces of several of the boilers in at least two of the ships of Admiral Sampson's fleet were very badly bulged, or, as it is called, down in the flat (cylindrical) portions and in the corrugations. This appeared to be a natural result of the necessity of using salt water on blockade duty off Santiago. A ship with several boilers often might spare one to be connected up as an evaporator, and by thence running a large pipe to the main surface condenser, form a satisfactory, though temporary, distilling system. This alone was not sufficient in most cases. The daily loss of fresh water on such blockade duty was far greater than the supply. Off Santiago

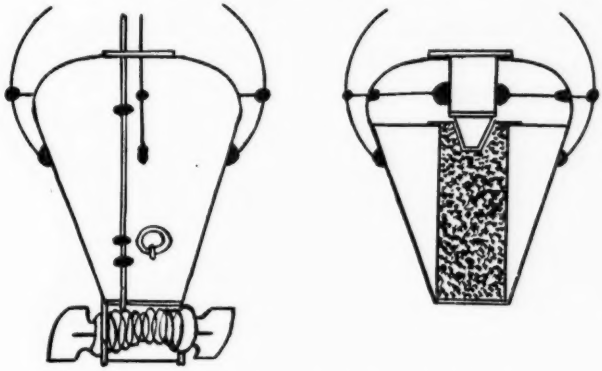


FIG. 17 SPANISH SUBMARINE MINE FROM GUANTANAMO BAY.
Taken apart on U. S. S. Vulcan.

no anchorage was possible, the ships being more or less under steam all of the time, and such arrangements outlined above proved insufficient. Salt water had to be used in the boilers of several of the vessels to make up this loss to a great extent. In time this resulted in over heating and bagging the furnace crowns.

To jack the furnace crowns back into their original positions, cast-iron formers were molded and finished on the Vulcan and fitted to the shape of the crown or corrugation, as the case might be. That portion of the furnace-crown requiring to be jacked up was then heated to a cherry red by an improvised charcoal furnace placed underneath and supplied by hand or electric blower air blast. While at this heat it was readily jacked up into the former natural

shape and allowed slowly to cool. The excellent quality of the mild steel boiler plates used in these naval vessels made this work entirely feasible without seriously or permanently impairing the strength of the furnaces.

The Vulcan's part in the war was entirely constructive—portions of machinery were made on board the Vulcan to replace that broken or disabled in duty or in action on the other ships. Besides the larger part of the work done for the Steam Engineering Department of several of the vessels, extensive repairs were made for the Equipment, Navigation, Ordnance and Construction departments. Thorough overhauling and repairs were made for the different vessels of their main engines, reversing or jacking engines, capstan engines, winch engines, crane engines, blower engines, steering engines, dynamo engines, dynamos and electric motors, ice machines, steam pumps of various types, main and auxiliary steam boilers, and extensive repairs made to boilers, engines and pumps of steam launches. A large amount of repair work consisted in refitting and re-arranging piping systems, both iron and copper, and in making and repairing numerous copper pipes. Steam gauges were standardized. Electrical fittings on many of the ships were altered for more convenient distribution. Manufacturing orders were executed for many spare parts, such as air-pump valve-seats, ash-hoist castings, plug cocks, wrist pins of small engines, special studs and screws, special spanner and socket wrenches, reducing hose couplings, blank and ring flanges, check valves, valve-stems and bushings.

Many new brasses, piston rings, pistons, cylinder covers and rods were made for auxiliary engines and pumps.

It may be interesting to note that the vessels of the auxiliary naval force required, in general, a different type of repairs from those of the regular navy. That is to say, repairs were frequently called for by the auxiliary vessels in order more thoroughly to adapt them to the new conditions of the naval service and calling therefore for many changes and alterations other than those required by direct repair work. In general, the following classification of repairs included almost all cases:

(1.) Repairs due to structural weakness.
(2.) Repairs due to hard service and rough usage.
(3.) Repairs required by maltreatment in service.

Requisitions for supplies not on hand were filled, in many cases, by manufacturing the required articles from raw material in the stock

carried by the Vulcan's stores. Among these particularly were large orders for special bolts for gun mounts, brass screws for condensing and distilling apparatus, and in some cases special brass pipe castings and fittings were made.

In the line of ordnance work, gun mounts were made for the new six-pounders sent down to be mounted on the small converted yachts, alterations were made in old gun mounts, new foundation plates were made for others; and in one case an entirely new bronze casting was completely finished for replacing a cracked gun-mount bracket. Firing pins, gun springs, etc., were made to replace broken or damaged parts and detent triggers of turret guns fitted with new steel blocks.

In the line of equipment and construction work for the different ships, the most varied kinds were executed by the Vulcan's force, comprising orders for hammock hooks, boat hooks, cleats of various shapes and sizes, swinging booms complete, gangway ladder fixtures and fittings, ship's small boats overhauled and fitted out, new rudders, pins and pintles for small boats, anchor stocks, ring pins and shackles. The larger work of this nature comprised straightening out side plates with specially-made strong backs fitted out on the Vulcan, with deck and hand rail stanchions and repairs to anchor and boat davits.

In the first forty-one days of the Vulcan's work in Guantánamo Bay, there were 528 orders for repairs filled and 256 requisitions for supplies.

There was little to disturb the routine work of the Vulcan till the signing of the protocol. The Vulcan's steam launch maintained nightly picket duty, up the bay, towards Caimanera, and just below the fort opposite, and was fired on once or twice without effect. The French flag, by permission, was allowed to fly over the Plaza, on the fourteenth of July, in honor of the fall of the Bastile, seeing which a French man-of-war took courage and came into the offing of Guantánamo Bay, till brought to by a blank shot and two solid shots fired across her bows from the Marblehead. Pending the delay of the surrender of General Toral to General Shafter, the Spaniards became bolder, and a steam launch from the Marblehead picked up a straggling decoy on the beach, and received in return the fire from shore riflemen, concealed in ambush. The strain of the work reached the climax in fitting out the ships selected for the coast of Spain, when we learned of the signing of the protocol, Friday evening, August 12th. At 10:00 A. M., Sunday, August 14th, Admiral Sampson set sail for New York, with all of the battleships.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

VI.—COMPARISONS AS TO EFFICIENCY OF MACHINERY AND METHODS.

COMPARISONS are odious, but they are frequently instructive. The engineer should be cosmopolitan. If in any particular case his work is superior to that of others, he should know the weaknesses of his rivals and avoid making the same mistakes. On the other hand, if sufficient evidence is offered to indicate that he is not up to date, he should certainly want to know the why and wherefore. A fair comparison as to mechanical progress is desirable for both sides—European and American.

It is usually admitted by those who have had the opportunity of making comparisons, that America leads the world in machine tool design, and in the economic employment of mechanical methods. At the same time, there are many things accomplished in European workshops that would surprise those Americans (not by any means a limited class) who have an unduly exalted idea of the greatness and superiority of all that is produced in their own country. There is nothing in America that excels some of the manufacturing establishments I have visited in England, either in equipment, organization or quality of product. I hardly think any American manufacturer turns out such a monument of mechanism as the English loom makers will supply for $150. The marine engineering work of England is the admiration of all mechanics, and the wonder of the American who employs different methods for producing this class of work. Some of the locomotive works of England are splendidly equipped and do good machine work, although their plants are not as a whole so up to date as those of the American establishments. I have never seen anything in America superior to the work turned out of the German small arms factories, considering quality, finish, and cost of product. It is unfair to make comparisons without duly considering surroundings and history. The state of the machine tool art, like other industries in America and Europe, has been mainly shaped by economic conditions. What those conditions are, and how they have operated, it is beyond the scope of this article to discuss. It is sufficient to

state that in America the tendency is to reduce all production to machine operations. In European countries the tendency is to employ machinery as an assistant to production, and to rely on skilful hand labor to complete, and in some cases to produce outright, the highest grade of work. The consequence is that we find in America the highest skill and talent devoted to the production of machinery on which the article is made, and in Europe the highest skill devoted to the production of the article itself. As far as talent is concerned there is as much on one side of the Atlantic as on the other; it is simply progressing on different lines.

Warner and Swasey, the well known makers of machine tools and observatories, formerly sent to Germany for all their fine levels used in astronomical work, although they are now able to get them in America. I am told that Reichel, a German maker, has one in his workshop so delicate that it indicates the deflection which takes place when pressing against the walls of the room. His levels are purely a product of specialized, skilful hand work, in which the Germans in many instances excel. It is done with the care and pride of an artist, who repeats the same painstaking operations on every piece of work he produces. The spirit and influence of the old craftsman is not dead in Europe. It lives in nearly every industry. Tedious and costly hand work does not seem to worry the European as it does the American, who is never satisfied with producing by hand if he can invent a machine or appliance for doing the same labor. A good example of a pure Americanism is found in the works of this same company which sent to Europe for its fine levels. Warner and Swasey have been for several years developing a graduating machine which for accuracy and delicacy is probably not to be found in any European machine shop. It is interesting to note that at the time that I saw this machine it was in charge of one whose speech had the strong accent of the Fatherland. The machine is for automatically graduating the degrees of a circle, and is so sensitive that the heat from the human body destroys the accuracy of its work if it should be operated by hand. The part is inserted, the machine set in motion, and no one allowed in the room until the work is completed, when the machine stops automatically. The apparatus is not only a splendid example of design and workmanship but also of the trouble, expense and study of detail to which the American will go to avoid the tiresome repetition of hand operations. The spirit which prompted its conception is the same that is moving the American

to invent the automatic machinery and labor saving devices, for which he is noted. It is the spirit which is lacking in European industry. The important question is: by which method, the European or the American, is the greatest industrial progress possible? I shall attempt to deal with methods, tendencies and general characteristics which directly interest the maker and user of machine tools, and not to go into detailed comparisons as to the relative merits of machinery, which could not be properly undertaken, except in the form of a treatise.

Although machine tools of all classes are produced by European makers with the full complement of automatic movements and labor saving attachments, the use of such machines is by no means common in European workshops. They are not demanded by manufacturers nor workmen. The result is that the usual catalogue machine of the European maker is lacking in the many handy devices and power movements almost invariably found in the regular article produced by the American maker. This is true of nearly every class of light machinery, but in the heavy millers and slotters the English maker is well to the front. In fact, some Americans frankly admit having copied the English design. At the same time, Americans are having good success in selling heavy machinery in Europe, easily competing in price and quality. With no trade union to dictate, and everybody working under high pressure, the tendency in America is to make movements automatic wherever it is possible; to use the automatic feed, in the lathe, the drilling machine, the milling machine, and to place one workman in charge of several machines which are so made that by the simple movement of a lever or by a couple of turns of a hand wheel everything is quickly made ready for the next operation. There is the greatest indifference amongst Europeans to the value of these minute and even second saving devices which are a marked characteristic of American machine tools. I have seen factories recently erected in England with an entirely new equipment in which there are rows of lathes, perhaps ten or twelve in number, without automatic feed of any description. The proprietor, when questioned as to why he ordered lathes without automatic feeds, says: "Oh, we are obliged to have one man to one machine anyway, and if he didn't have something to do he would go to sleep." This is not an extraordinary case but rather a common one. I have also seen in European factories employing thousands of workmen, in departments where literally millions of one particular

part are made, the most expensive operations performed with hand tools. The hand operations which are so commonly seen in European workshops are practically unknown in America. I believe an investigation would show that a large percentage of American imports consists of those goods which are largely the product of skilful hand work; articles which the American has not yet developed the machinery for making, or which cannot in any case be produced by machinery.

Not only in the development of automatic movements for the ordinary machine but also in the purely automatic machine is the American maker leading the European. Good examples of this are the automatic screw machine and the automatic gear cutter, both of which are being sold in large quantities to European manufacturers. It is remarkable that the automatic screw machine is not made to any extent by any of the large European machine tool makers, with the exception of the Loewe Co., in Berlin. It may be said to be purely an American product, and good machines are made by half a dozen well known firms. Its application is being extended every day, although the field for its usefulness is scarcely touched in Europe, bicycle work excepted. In the bicycle trade enormous orders have been given to American makers,—for 25 and 50 machines at once. It is almost invariably the case that these machines produce from 10 to 20 per cent. less in European shops than is turned out by them in American factories.

Although the automatic gear cutter is made by European companies, I should say that the sale in Europe of the American article is far in excess of the home product. This may be partly due to the fact that a large number of European manufacturers—many, machine makers themselves—still adhere to the cast tooth, arguing that it is stronger and when accurately cast, will wear much longer. As a matter of fact, it is rarely accurately cast, and the more perfectly formed cut tooth has much better wearing qualities than the usual imperfectly cast tooth gears with contacts only here and there. The cast tooth is sure to find a lively competitor in the tooth cut by the American automatic gear cutter, with feeds varying from 1″ to 4″ per minute, quick returns and automatic indexing. One operator can in many cases attend 6 machines.

The universal grinding machine in its perfected form is purely an American machine, and has been largely developed by the Brown & Sharpe Manufacturing Co. The full fledged universal grinder is a rarity in the average European workshop. It is

looked upon as a refinement beyond the requirements of the ordinary mechanical outfit, while in America manufacturing plants are hardly considered complete without them. There, its field is no longer confined to the "tool room" equipment and fine gauge work, but is extended to the manufacturing of cylindrical parts, which by its aid can in many cases be more cheaply and accurately finished than on the lathe manipulated by the most skilful "turner." It will surprise many manufacturers also if they investigate the possibilities of the grinding machine for finishing flat surfaces, taking the place of the file and hand polishing. Where one machine is used this will scarcely be cheaper, but when four or more surface grinding machines can be operated by one man the work is not only cheaper but far more accurate, and of better appearance than when finished by hand.

Another machine which, although probably made in some form or other in Europe before a machine shop existed in America and is still made by many European makers, is in its highest form and extensive use distinctively American, is the heavy turret lathe. I am referring particularly to the type known as the flat turret lathe made by Jones and Lamson, to the Gisholt turret machine, and those of other well known makers for turning out a similar class of work. The merits of both of the above machines are now so well known that it is not necessary to mention them here. The Jones & Lamson Co. state that their foreign business is keeping pace with the home trade, which is an indication that the machine is appreciated by European users as well as by American. In spite of their success there is but one maker in Europe who produces anything that can compare with the American machine, that is, Herbert, of Coventry. The Jones and Lamson and the Gisholt lathes greatly reduce costs of manufacturing parts that were formerly made on the ordinary lathe, and in many cases save from 50 per cent. to 100 per cent. As far as I have seen, the European manufacturer of brass goods is lamentably behind the American, for the simple reason that he has not made use of the completely developed turret tools which are common in America. The success of the American turret machine lies chiefly in the perfection of the tools. Rigidity and power can easily be secured in the machine itself. As in other cases, the product of the American turret machine in Europe is often 20 per cent. less than from the same machines when operated in America, even when the European user imports American material.

The chief reason, however, for the failure of the highly productive turret machine in European shops is the want of skilful, intelligent tool makers; men like those who in America receive from $3 to $4 per day, and even more, and easily keep a dozen complicated machines in running order, producing the utmost of which they are capable, and maintaining their accuracy day after day. Such men are the highest wage earners and the cheapest producers which a factory can secure. Judged by the American standard, they do not, as a class, exist in Europe. As before stated, it is not because skill nor ability is lacking in the European mechanic, but because his talents are working in other directions. The most skilful are too frequently employed in producing the article itself rather than in perfecting and maintaining machinery which can be manipulated by the unskilled operator and, in many cases, run at a speed that would give a paralytic shock to the jog-trot European hand worker.

That nation which is most advanced in the art of making and using machine tools is sure to lead in general manufacturing, and, conversely, those who lead in manufacturing must necessarily make use of the most highly perfected and accurate machine tools. In the maintenance as well as in the production of labor-saving machinery, Americans are naturally farther advanced than Europeans. Skilful labor is employed for this purpose, and manufacturing establishments are usually fitted with the best of machines and tools to be used solely for repairs and re-production of plant. Without such a department, jigs, fixtures and complicated, expensive, special tools can not be kept in an efficient condition. The failure of American machines to produce as much as they do at home is also partly due to the fact that European manufacturing establishments are but rarely fitted with good "tool rooms," with the universal milling machine, the universal grinder, shaper, accurate lathes, cutter-grinders, etc. A great deal of manufacturing is done in England and on the continent at a very low price, but it is in many instances of inferior quality, for no other reason than that the tools and fixtures are not properly repaired nor kept in order. Good facilities and the proper mechanical ability are not commonly employed. It is surprising to what extent even the simple appliances for keeping milling cutters in order are wanting in European manufacturing establishments. The milling machine is not used as extensively in Europe as in America, neither in respect to variety of work nor in the way of complicated and broad

cuts. When trying to introduce milling machines I have repeatedly been met with the statement that the original cost and maintenance of cutters would be so great that there would be "nothing in it." The simple and inexpensive planer tool would be largely superseded by the milling cutter in European shops, even where small quantities are turned out, if the care of cutters was more generally understood, and if the facilities for maintaining plant were looked upon as indispensable to good and economical manufacturing. It is the same with tools and fixtures as with machinery, even worse; the first cost is often proportionately so high that the cost of the article, which the machines and tools are made to produce, receives comparatively little consideration, no matter how much it may be reduced by the adoption of the proper machinery. European manufacturers may adopt all the Yankee machines they can buy, but if they continue to employ the cheap tools and primitive fixtures commonly in use and do not invest in more effective (though not always more complicated and expensive) tools, and if they do not have better facilities and higher class labor for maintaining these tools, they can not compete with the American manufacturer.

It is much easier to compare broadly European and American manufacturing plants than to contrast individual types of machines. The average American manufacturing establishment, with its full complement of machines, tools, fixtures, auxiliary plants and skilful labor, is far in advance of the average European. I believe it is also true that the average American machine tool is more effective than the European. It surely is in America, operated by American labor. It is, however, not always a success in Europe in competing with the home product, even when manipulated by a "native." The effectiveness of a machine is dependent on its design, on the operator, and on the material to be worked. European machines of certain classes will probably hold their own against the American for some time, for the reason that they are better understood by the operator and are better adapted to the available material. This would be especially true of the English lathe and turret machine. European cast iron, brass and steel are harder, and less accurate in form and size than the American article. More material has to be removed by the European, and its quality is less studied, with a view to cheap manufacturing, than in America. Cast iron is hard, rarely pickled or annealed to remove sand or scale, and is not so accurately moulded. Its composition

is not so carefully studied with a view to machining. Neither cast steel nor machinery steel is so accurately made to size, nor is the quality so well adapted to special purposes, in Europe as in America. I think in some cases American machine tool makers have gone too far in their efforts to secure a material that can be rapidly machined, and have made the machine less effective and less durable in their endeavors to make it cheap and still of good workmanship. This would be particularly true when making for the European market, where the machine is sure to get rough usage and has to work on hard material. For various reasons, the speeds and feeds of American machine tools are higher than on European; from 10 to 20 per cent., I should say, and in special cases even more. Lathes and turret machines have a coarser feed per revolution; milling machines have faster surface speeds and coarser feeds; planers have a quicker working stroke. In methods and devices for easy handling and quick manipulation the American machine is in advance of the European. In weight and distribution of metal, the American machine is well suited to American conditions, but not always European. The phenomenal rates of feed, about which we have recently heard so much, have not been maintained in practice, although the results of these experiments have been beneficial in strengthening and otherwise improving the design of the milling machine. The wonderful results which were promised from the milling machine when running the feed with the cutter have not been realized. I have seen in an American machine shop milling cutters operating on a steel shaft with a feed of 18 inches per minute, cutting a keyway ½ an inch deep and ⅜ of an inch wide, but when questioned, the foreman stated that this was hardly an every-day rate of feed.

As to the style and appearance of machine tools, to the American eye the European article looks clumsy and heavy; to the European eye, the American machine looks light and flimsy. It is largely a matter of taste and custom, of course, but certainly American designers pay more attention to artistic effect and graceful lines than the European. It is of undoubted commercial advantage to do so. It is a "selling point," the attainment of which adds nothing to the cost of the machine and assists to secure orders. In heavy machinery American and European style and form more nearly approach each other. Although the clumsy machine may be capable of producing just as much and as accurate work as the more graceful in form, still the latter, other things being equal, is evidence of more

careful design which in the end means greater usefulness. In machine-tool design utility is the first principle of beauty, but beauty need not be thrown to one side as a useless factor. While the American machine tools were mainly and originally copies of the English, characteristics of American design are now copied by many European makers, much to the indignation of some virtuous American makers who are continually pirating each others' patterns.

The usual American machine tool is superior to the usual European machine in the matter of accuracy and quality of workmanship. There are makers of low grade machinery in America and there are makers of high grade machinery in Europe, but there is however comparatively little really low grade machinery now sold in America, while there is an enormous amount of cheap machinery made in Europe. The recent statement made before the German Engineers' Club that the quality of American machinery is deteriorating is entirely misleading and untrue. For years the European trade in American machine tools has been practically confined to the best makers, those with a reputation like Brown & Sharpe, and Pratt & Whitney. The market for, and reputation of, American machinery abroad has been made by firms with a standing like the above. Inferior makers have followed in their wake and have sold quantities of machinery which had every appearance of the better quality article, in style and polish, but were of low grade workmanship and design, and sold for a much lower price. Great quantities of this second quality American machinery are now being sold in Europe; in view of this fact the report finds a ready belief amongst German engineers that American machinery is not of such good quality as formerly. The opposite is the truth. The quality of American machinery made by the best makers is improving both in design and workmanship, with an exception in one particular, perhaps. Some American makers, in their endeavor to reduce cost of manufacturing, are using material which, while answering perhaps every requirement of American practice, is of such a nature that it does not meet European conditions. American makers do not seem to realize that their machines must operate upon rougher and harder material than is commonly used in the States. I know of one recent case where feed screws in several milling machines of one of the best American makers had to be replaced because they would not stand the strain when working on the hard material which is commonly used in Europe.

In respect to prices, the American machine tool of highest quality is lower than the European of highest quality. In good grades of

machinery, not the highest, the American is also cheaper. This is due to specializing largely, and to other causes dealt with in a previous article. In really cheap grades of machinery I think the European takes the palm for the amount of cast iron he can supply, worked, to all intents and purposes, into the shape of a machine tool. It is surprising what an immense amount of machinery is still sold in Europe in competition with better grades solely on the strength of a greater amount of metal offered for the same or even a less price. It is likely that this trade is heavily encouraged by exporting houses whose enquiries alone are sufficient evidence to prove that they have no standard of value but weight.

The capital of the mechanical worker may be said to consist of his strength and skill, and the hand-tools which he possesses. In the development of these tools or aids to the manufacture and maintenance of machinery, America is far ahead of Europe. The American workman is individually much better equipped than the European with accurate, easily manipulated, labor-saving hand-tools. Accurate hand-tools are made by a number of European producers, but as a rule they are clumsy and lacking in the details which tend to make them quick acting and adaptable to a great variety of uses. Fine measuring instruments are extensively used and thoroughly appreciated by American workmen. They are not commonly understood and are comparatively little used by the European. Generally speaking, neither workmen nor employers recognize them as an important factor in the production of good machinery. A skilful workman may do a fine job unaided by fine tools, but he cannot do it as cheaply nor as quickly; without them interchangeability is practically out of the question. European employers should recognize the value of labor-saving hand-tools which are of as much importance as other auxiliaries, especially in the production of parts like jigs, fixtures and small tools. Some large American concerns furnish to all employees what they consider the necessary hand-tools and instruments, charging nothing for them except in case of misuse or loss. Aside from this, I think it is safe to say that a majority of the best American mechanics possess from 50 to 100 dollars' worth of the best quality of hand tools and measuring instruments, some even to the value of 200 dollars. I have repeatedly noticed the kit of the European mechanic to consist of nothing more than a slide caliper, costing perhaps 4 or 5 shillings, a sheet metal square, a hammer, a chisel or two, a centre punch and a little tin box of powdered emery. Verniers, micrometers, sets of accurate squares, a variety of scales, quickly adjustable dividers and spring

calipers of different sizes, surface gauges, a number of hammers, straight edges, centre gauge, and sets of wrenches is the common equipment of the better class American mechanical worker. It is interesting to note that enormous quantities of American tools of the above class are now being sold in Europe. Where they are tried and are in use they are preferred by the European to any others.

By the aid of improved machinery, that which at the beginning of the century was the luxury of the rich is now the comfort of the poor. Material and labor are no longer the sole factors of production. Assisted by machinery and tools, man's labor now converts the raw materials of nature into the useful, necessary and, in some cases, even the artistic paraphernalia of civilization with one third of the exertion formerly necessary. Even Russia, the latest competitor in the industrial field, has, with the aid of machinery, more than doubled, since 1861, the individual output of those employed in her manufactories. In the course of 20 years (1870-90) the number of persons employed in the American manufactures has more than doubled, and the value of their product has nearly trebled.* I mention these facts to show the important part that machinery now plays in modern industrial warfare. Few realize or stop to think how much we are indebted to the inventor and machine designer for the comforts, luxuries and necessities of our daily life. The loom which weaves our silks, cottons and woolens; the harvesting machines which reap our corn; the machinery which forms our bricks and mixes our mortar; the printing machine which makes the penny daily possible. Our food, clothing, furniture, literature, all are produced on machinery which it is practically impossible to make or maintain without the modern machine tool. European manufacturers themselves do not realize the important part that the machine tool plays in American industry, particularly in the maintenance of plant. As before stated, there nearly every industrial establishment of importance supports an auxiliary equipment of the best machines and small tools, and employs high wage earning mechanics for the purpose of keeping its plant in a high state of efficiency. Without this backing America could not have attained the place she now occupies in the commercial race against all European nations. It is the direct result of the high development in the art of machine-tool making that America can now send to Europe nearly every article of commerce required by civilized nations, pay freight and duties, and still compete with the home product. There are but few exceptions to this broad statement,—perhaps in textile fabrics and steamships.

* P. Kropotkin; Fields, Factories and Workshops.

Still I have lately seen suits of clothes made to order for a full grown man advertised at $4.95, and a number of orders for steamships have recently been placed in the States by foreign governments. A well known American maker of steam engines is regularly sending his product to different European countries, competing with local makers, and paying on an average 30 per cent, for freight and duty. Agricultural machinery has been sent to Europe for years by American makers; this machinery requires the most advanced machinery for its production; the castings for it are produced in some cases for less than one cent per pound, the steel and iron used costing but little more than cast iron. A very large business is done by American makers of pumping machinery in Europe. The recent excessive demand for railway supplies in Great Britain has driven orders to America, and locomotives are now being made there for English railway companies. It is well known that very big orders have been given to American concerns for the equipment of the new electric railways in London,—cars, engines, and electric apparatus, chiefly I believe on account of quick deliveries which could not be undertaken by European makers. I know of a number of orders recently placed in the States for large travelling cranes that can be delivered, including freight and duty, for the same price that the European maker can quote, with far quicker delivery and of workmanship that is superior. The completely erected steel structural work for a very large building has been recently supplied by an American firm to a European company for 15 per cent. less in price than that offered by European competitors. An American company is doing a good business in London supplying steam radiators. Although the boom is over, the American cycle is now a fixture in the European market, where formerly the case was reversed and America was a large buyer of the English article. Typewriters, which require, perhaps as much as any manufactured article, machinery of precision and high mechanical skill are almost exclusively made for the world in America. I know of but two factories in Europe producing writing machines, and these only make a comparatively small quantity. The United States exported in the year 1898 typewriters to the value of nearly two million dollars. American brass goods are finding their way into the European market, and users state that they are interchangeable in parts, which is not true of the usual European make. Bolts and nuts are now supplied to England from America, in some cases for 25 per cent. less in price than the domestic product.

America already has a good trade established with European

countries in steel and iron, particularly for those grades where accuracy is desirable.

Many European manufacturers are now sending to America for pig iron, rolled and drawn steel and brass, malleable castings, and, in some cases, for ordinary castings, for the simple reason that, in many cases when using European materials, it is out of the question to secure the product from highly developed accurate working machines which they are capable of turning out. This importation of American material is sure to be more extensively practiced as soon as it is more generally known for what a low price it can be delivered in European countries, freight and duty notwithstanding. In price American matrial easily competes with the European; in quality it is, in many instances, superior.

I recently saw the steel stores of a good sized cycle factory in Germany completely stocked with American material. The manager informed me that he orders all material from America after having made every attempt possible to buy accurate (guaranteed to run within a limit of 2 thousandths of an inch), easy working material in Germany. He had given German material thorough trials but could not get the right thing. The American material, with freight and duty added, costs him less than the European article. It seems to be a plain case of the European steel makers' failure to understand the value of accurate machinery and tools, and their maintenance.

In addition to the above items is, of course, the steadily increasing business which American machinery makers are doing with Europe. America exported metal working machinery to the value of $5,500,000 in 1898, mostly to European countries.

The inevitable conclusion is that America leads the world industrially. I have tried to show the important place the highly developed machine tool occupies in her industrial establishments. It is indispensable to accurate, cheap manufacture. It is the one factor possessed by Americans which Europeans can at once make use of; buy or copy and immediately apply to rejuvenate their out-of-date equipments. They are doing this, and have made a good start in adopting American machinery and practice in many of their industries. It is surprising, though, how many European manufacturers are jogging along with a mediæval trot, ignorantly, almost blissfully, unconscious of the progress that others are making. With respect to other conditions, however, which are advantageous to America in the industrial race, it is not so easy for Europe to cope. In commercial management she can, and does in many respects, although political institutions and

social customs do not permit such rapid changes (which are not always for the best although in the long run more progress comes out of them) as in America. New commercial methods must naturally follow mechanical and scientific improvements. Again, economic and social conditions in Europe are almost irretrievably opposed to the development of labor to as high a degree of efficiency as is common in the States. Equally favorable results can, for the present, be realized in Europe only in isolated cases where employers and managers thoroughly understand the case and are strong enough to organize and retain a *personnel* which can resist outside influence and environments. In such establishments the wage rate, per unit of time, must be high (for Europe), but per unit of product will be low. In the item of raw material European manufacturers can not hope to compete with the States. America is far richer in natural resources than Europe, and is better organized for the handling and distribution of raw products.

But what of the future? With an abundance of raw material, effective division of labor, the most advanced machinery and shrewd commercial management, is America possessed of all the elements by which she can retain her industrial supremacy? I think not. She has difficult problems before her which are already pressing for solution and must soon receive recognition. Undoubtedly the division of labor, in which America is so far advanced, is, if properly organized, the most economical method of production, but if carried to an excess, as it is fast becoming the case in America (it is moving in the same direction in Europe, although more slowly), there will be a terrible reaction on the part of those workers who perform the routine operations in the modern manufacturing plant. The free social life, out of which progress has come in America and which is still the vital element of its industrial development, is slowly forging the instruments of its own destruction. The factory and machine shop hand is becoming the slave of the automatic machine and the model shop. No diversity in his labor, no development in his mind, no progress from his experience. This is the danger to American workers. To avert it, they must soon seek methods of diversifying the life of the routine laborer, giving him a better education and teaching him to think, to study, to improve and to find time for recreation. If this is not done we cannot look for the rapid improvement in the future that we have seen in the past, for it is from the mass of workers that most of the American inventions and improvements in machinery have come.

In America petty industries practically do not exist. It is the land of large factories, big combinations and high pressure specialization. Progress is unhampered by labor combinations. In Europe conditions are different. Petty industries still survive. Organized labor fights specialization, employers' combinations, and labor-saving machinery. The same economic tendencies may be observed but they are not so far developed. Both continents are striving for the ascendancy in home and foreign markets, but in neither do we but rarely find a manufacturer who realizes that social economic problems exist. How keenly all are bent on studying the machine, its design, its output, care and development. How few take any thought for the care and development of the human machine, that most important of all factors in reducing the cost and improving the quality of product. How many employers think of the condition of their work people as often as they do of their truck horses, of their stokers as well as of their boilers? What manufacturer cares as much for the food of the milling hand as he does for the quality of the lubricant of the machine which the milling hand attends, or gives as much anxious thought for the longevity of the turner as for the lathe which the turner runs? Who would expect profitable returns from a machine quartered in the damp and stifling atmosphere in which thousands of our factory hands live? Both Europeans and Americans are straining every nerve to increase the productivity of their machinery, but there is no competitive strife amongst manufacturers which aims at creating a class of well fed, well clothed, sheltered and educated, and consequently strong and intelligent, operatives. Yet without such, good machinery and useful inventions are impossibilities. It is from the ranks, those who come in daily and hourly contact with the realities of production, that improvements come. The human being which forms the most important part of a manufacturing establishment, receives too little consideration from the employer. Neither in Europe nor in America have the social and economic questions received the same attention that the mechanical and scientific have. They cannot be put off much longer, however. I believe the nation will advance most rapidly which grapples with these questions first, and combines the study of the welfare of its workers with that of improvements in its mechanical equipment. To which hemisphere will the reward and the honor be given?

HYDRAULIC TRANSMISSION AND DISTRIBUTION OF POWER.

By E. B. Ellington.

HAVING analyzed the cost of generation and transmission I will now proceed to the question as to what can be done with hydraulic power when obtained. In order to get a clear idea of the economical limitations of its use, it is necessary briefly to refer to the properties of falling water flowing under

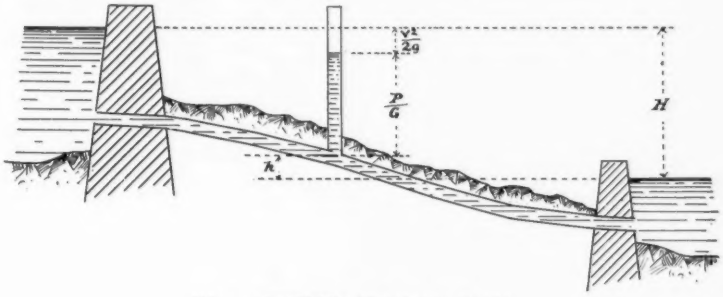


FIG. 1. PROPERTIES OF FALLING WATER.

pressure. This is very tersely stated by Professor Unwin, as follows :

Suppose the water to descend at a uniform rate through a pipe (Fig. 1), which we may imagine frictionless. At any point h feet above the lower level, the water will in general have acquired a pressure p and a velocity v. And in that case we know that

$$H = h + \frac{P}{G} + \frac{v^2}{2g},$$

where h is the unexpended part of the fall, $\frac{P}{G}$ is the energy corresponding to the pressure and $\frac{v^2}{2g}$ the energy corresponding to the velocity of each pound of water. Consequently the head may take three different forms, and, at whatever point of the pipe we make the examination, these three positions of head add up to the same total amount.

The three methods of utilizing the power at disposal require corresponding machines. The first, or the mere weight of the water, seldom is in evidence in hydraulic machines working under high pressure. It is principally used in overshot wheels, which may be

considered out of date since the advent of the turbine, but there is one application of the direct weight of water in a hydraulic machine which I will explain, as it involves a rather neat hydraulic problem.

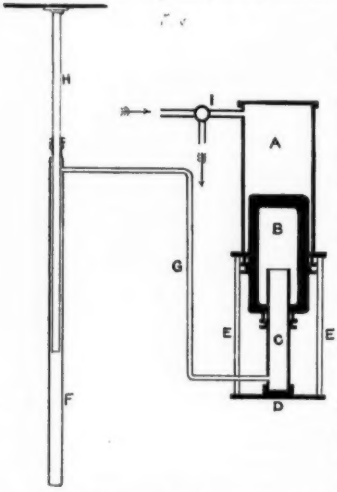


FIG. 2. HYDRAULIC COMPRESSION CONVERTER.

It is a case of conversion of low-pressure into high-pressure water. A is a low-pressure cylinder. B is a weighted moving ram working in A. C is a fixed hollow ram with base D secured to cylinder A by the tie-bolts E E. F is a lift-cylinder communicating with C by the pipe G. H is the lift-ram working in F, and of the same capacity as C.

Now, it will be understood that when the lift is down the ram H at the bottom of the cylinder F is immersed in water, and has displaced water previously in the cylinder and equal to its immersed bulk. The displaced water, passing through G into C, raises the ram B to a height corresponding to the ratio of the respective strokes of the rams. When H is at the top of its stroke it weighs more than it did at the bottom by the weight of the amount of water previously displaced. But while H is coming out of the cylinder and increasing in weight, B is also coming out of cylinder A (B, C, G, and F forming a closed system), and is also increasing in weight by the amount of water flowing into A from the supply-pipe I. By properly proportioning the diameter of the rams H and B, the apparatus is in perfect balance in every position, notwithstanding the disturbance due to the variation in the load. I should mention that in ram-lifts it is often important, especially with low-pressure supplies, that this variation in load should be balanced, as it may be considerably more than the maximum net load in the cage. That it is really the dead weight of the water in the cylinder A which does the trick, is proved by the fact that if the apparatus is laid on its side, though the machine will work it will not be in balance. It is a curious illustration of the effect produced on a hydraulic machine by a mere change of position without alteration of any of the working parts.

In nearly all the hydraulic machines it is either the pressure directly or the velocity due to the pressure which is utilized. Unfortunately, however, the weight of water can never be disregarded, and it is the weight which determines the most important limitation in the economical use of hydraulic power. It is impossible to employ high velocities of flow in the mains and machines except for inappreciable distances. The loss by friction in transmission increases as the square of the velocity, and for these reasons a greater velocity in the mains than six feet per second can not be permitted. The average velocity of flow through the mains in London is not more than four feet per second. In the pressure-machines themselves a higher velocity is allowable, but eight feet per second is rarely, if ever, exceeded. It is clear, therefore, that where the pressure is directly utilized it can only be with a comparatively slow-moving ram. It is precisely in this class of machine where hydraulic power gained its laurels, and in which its position remains unshaken to-day. It is clear that the higher the pressure the smaller the machine and the less the weight of water used to do a given amount of work. The less the weight of water the greater the velocity that may be allowed in the machine, and the greater the power that can be supplied through a given-sized main.

The limit of pressure as regards the mains is their cost, which increases in a higher ratio than the pressure, but the practical limit of the pressure of a general supply is the convenience of the consumer. It is doubtful whether there is any advantage in fixing pressures for public supplies much above 1,000 pounds per square inch. The supply given in Manchester and Glasgow, at about 1,100 pounds pressure, has been very successful, especially in the former city, where so much bale-pressing is done, but in London 750 pounds has proved a quite satisfactory pressure; yet if I were laying out the supply in London at the present time, I should provide for a maximum of 1,000 pounds.

Hydraulic pressure is, then, peculiarly adapted to cases in which a great effort has to be exerted through small space, and in which comparatively few reversals of motion of the pressure-ram take place. Water being practically incompressible, it follows that when the pressure is constant the same power is exerted throughout the stroke, and a further limitation of superiority over other kinds of power has to be made, namely, that the demand for power should be intermittent, *i. e.*, the power should be exerted during short periods of time. These conditions are fulfilled in nearly all lifting

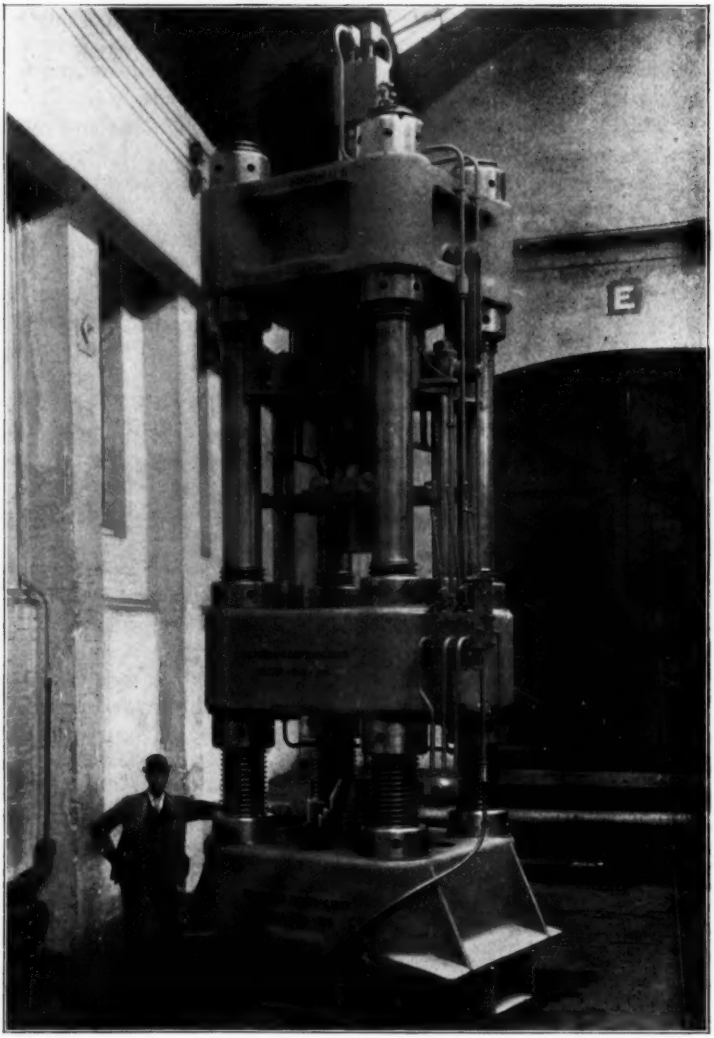


FIG. 3. 2,500-TON CARTRIDGE HEADING AND INDENTING PRESS, WOOLWICH ARSENAL.

and pressing operations, and to a limited extent in haulage. The incompressibility of water gives the further important advantage in lifting-machines that no brake is required. When the valve controlling the motion is closed, the water in the hydraulic cylinder is the brake. As a matter of fact, the pressure in the working-cylinder is never constant, but varies with the resistance, and when the loads are below the maximum the speed of working is increased; and as an increase of speed very rapidly absorbs the surplus power by fluid friction, hydraulic machines cannot race the water itself without any special mechanism acting as an automatic brake.

One of the most important uses of hydraulic power is for forging-presses. The hydraulic press in all large forging work has in recent years superseded the steam-hammer, in well-equipped establishments, and they are the largest hydraulic machines constructed. Four thousand ton presses are common and there are several of 10,000 tons. They are worked with pressures up to three tons per square inch.

It may, I think, be stated with confidence that the modern system of heavy forging depends for its success on the peculiar advantages of hydraulic power for pressing operations.

For pressing I imagine nearly every engineer would admit that hydraulic power is supreme. If hydraulic power is the best system for presses, the conclusion can hardly be avoided that it is also best for lifting. Strictly speaking, a hydraulic press is the essential feature of every hydraulic lift or crane. It is true that there are cases of lifting-machines worked by hydraulic engines. Such machinery can be nearly equally well worked by a steam-engine, a gas-engine, a dynamo, or a compressed-air engine. A real hydraulic lift or crane is, however, one in which hydraulic presses constitute the lifting appliance. In many cases, as in any simple ram-lift, there is in fact no clear mechanical distinction between a hydraulic lift and a hydraulic press.

What I wish to point out is that there is really no such thing as a steam-crane or a steam-lift or an electric-lift in the same sense as there is an hydraulic lift or crane. It is often advantageous to work a lift or crane by steam or electricity or by gas, but, broadly speaking, it is not, and apparently can not be, so worked directly.

Hydraulic power stands quite alone and apart from all the other systems of power-distribution in virtue of its pressure being applied directly to the lifting appliance without the intervention of any so-called engine. All other kinds of power require ordinary gearing. Other systems of lifting-machines are thus, mechanically consid-

ered, fundamentally and necessarily inferior. Of course, in engineering as in everything, it is often impracticable to use the best method, and it not infrequently happens that what is best from one point of view is not so from another; but I am on sure ground when urging that there is always a *prima-facie* case for using hydraulic power for lifting operations when such power can be had. Hydraulic lifting-machines are safer, owing to the direct action of the pressure, the absence of brakes, the simplicity of construction, and the certainty of their control.

With full loads hydraulic lifting-machines possess great econ-

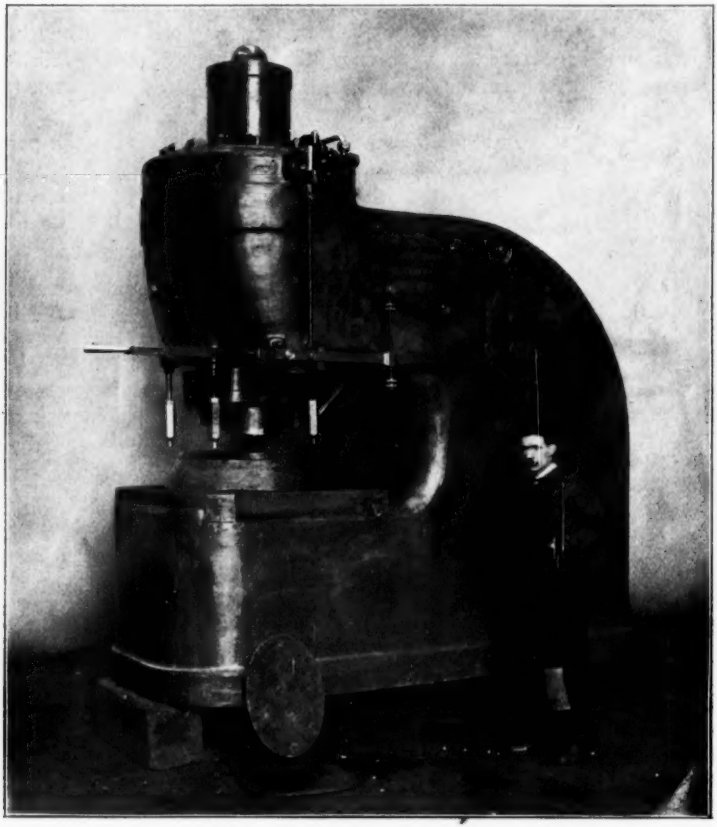


FIG. 4. MANHOLE SHEARING MACHINE.
For 23 x 16 inch manholes in ¾ inch steel plates.

FIG. 5. HYDRAULIC WAGON HOIST FOR MIDLAND RAILWAY.

omy, especially where direct action can be used, as in an ordinary direct ram, coal, or wagon lift. The efficiency may be as high as 95 per cent., and even in suspended lifts, when the stroke of the ram is often multiplied eight or ten times, the efficiency may be 75 per cent. At light loads the economy is less, but it is usual where the loads

vary much to make the machines of double or treble power, and in this way machines are kept working near their respective maximum efficiencies.

As to relative economy, it appears that a good electric lift takes more power to run with a very light load, or no useful load at all, than the corresponding hydraulic machine at full load.*

On every ground the superiority of the hydraulic system for the more ordinary kinds of lifting operations is maintained.

Before leaving the subject of hydraulic-pressure machines, I should like briefly to mention the use of hydraulic power for pump-

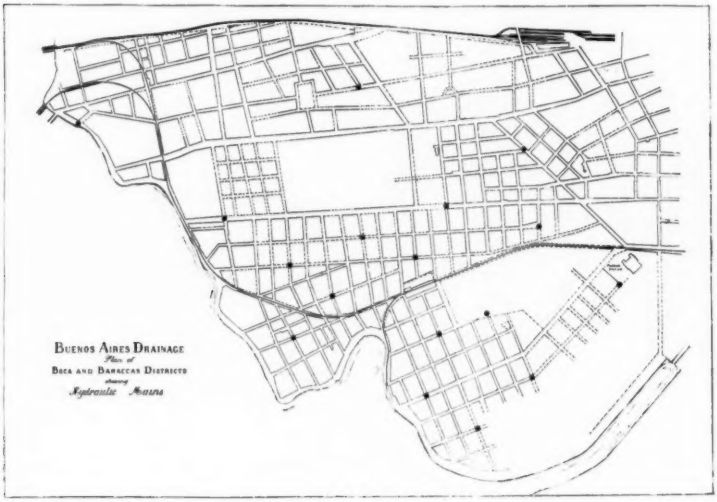


FIG. 6. PLAN OF HYDRAULIC MAINS AND SUMPS, BUENOS AYRES DRAINAGE SYSTEM.

ing. I refer more particularly to sewage-pumping. Water-pressure mine-pumps working in lower levels have been in common use for a great number of years. Pumping, especially against a constant head, seems to be one of those operations for which hydraulic pressure is admirably adapted. A complete hydraulic pump may have only one moving ram. The action can be made automatic, so that a large number of hydraulic sewage-pumps located at various places in a town can be worked from the central station, the pumps automatically adjusting themselves to the varying flows of the sewage at different parts of the

* See Ravenshaw on "Electric Lifts," and discussion, Minutes Inst. C. E., Vol. CXXX.

town. The power-water used helps to flush the drains. A slight variation in the size of the power-rams enables a standard pattern to be used at all the substations, even when the elevation is very variable. The efficiency of the pumps is high, and the plant simple and durable. This system has been adopted on a large scale with great success at Buenos Ayres and at other p'aces.

Now, it is difficult to see how electricity could be used for this purpose with anything like the mechanical directness and simplicity of the hydraulic machines. Pumps you must have in any case. These pumps must be geared to reduce the high-speed dynamo to the necessarily low-speed pumps. Where hydraulic power is not available and electricity is, the question would assume a different aspect, but the electric can not be the best system as a matter of mechanics.

For this work of sewage-pumping many engineers may prefer compressed air, and the apparatus required by compressed air as

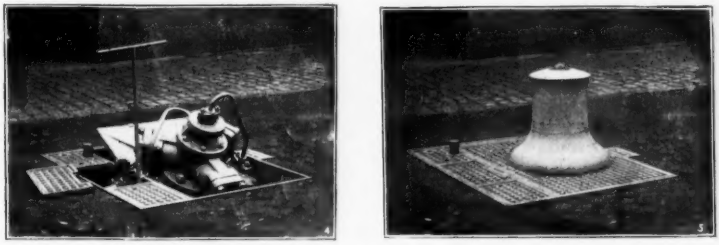


FIG. 7. STANDARD 1-TON TURNOVER CAPSTAN, IN POSITION AND TURNED OVER.

carried out under the Shone system is even simpler and more direct than the hydraulic, as the pumps may be said to have no moving parts. As compared with hydraulic power, however, the efficiency is very low. The two great desiderata in all mechanical contrivances are simplicity of construction and efficiency (*i. e.*, economy) in work. These two essential elements are often woefully antagonistic, but both arn special characteristics of typical hydraulic machines.

For reasons stated, hydraulic pressure is not very suitable for rotary engines for ordinary purposes, such as driving the machinery in a work-shop, and in most cases where the power is used for general work it is better to utilize the velocity of the water by means of turbines instead of pressure. There are, however, a few applications in which the superiority of hydraulic-pressure engines has been thoroughly established. The most important of these is for the

working of capstans in railway-goods yards and in docks. In this case the work is intermittent, great power has to be exerted for a short time, and the control is perfect. The hydraulic engine goes into a very small compass, and can be attached directly to the capstan-head. Hydraulic-pressure machines also seem to be preferred to any other system for working the bellows of organs. A considerable number of such machines are connected to the hydraulic-power mains in London, and in this case also one of the most important elements of success seems to be the perfection of control obtained. I have already referred to the gigantic forging-presses now so extensively used in steel-works, but there are a number of other workshop-tools in which hydraulic pressure has eclipsed all other systems. This is particularly the case in riveting-machines and boiler-shop tools generally, in which hydraulic pressure can be made to take the place of geared machines. Hydraulic-pressure machines have also been largely used on board men-of-war and in the merchant marine for gun-work, turret-turning, steering-gear, cranes, and capstans. In many of these operations certainty of control is what is most wanted, and it must be admitted that hydraulic machinery stands at the top of the systems in this respect. It seems to me, however, that there is much to be said in favor of electrical transmission on board ship, and that its advantages are so great that it may become the paramount power for doing the odds and ends of the work of a ship, now performed by steam or hydraulic power.

The facility with which electricity can be conveyed from point to point, the small space in which the central engines and dynamos can be placed, the comparatively small weight of material required to develop and utilize the power wanted, and the fact that electricity must be obtained for lighting in any case, all point to the desirability of its use on shipboard where practicable. The question is whether these advantages are sufficient to warrant its adoption for lifting and similar operations when doing so would undoubtedly entail a less effective control, diminished safety to the men engaged on the work, and a greater risk of fire. It is to be remembered that hydraulic power has displaced steam in the best-appointed ships, and for similar reasons it may continue to be preferred to electricity. A good deal more experience is required before any definite conclusion can be drawn.

I now come to the third method of utilizing the energy of water flowing in a pipe under pressure. The velocity of the flow from an open-ended pipe is $8\sqrt{h}$ multiplied by a coefficient which varies

with the nature of the orifice. The head (h) must be, of course, the effective head at the orifice; that is, the real head less the loss due to friction in the pipe. There are ways of utilizing the energy of the velocity of flow of water in a river or an open channel, such as the old undershot wheel, but in connection with the subject of the distribution of hydraulic power it is not necessary to deal with any applications of the principle except where the energy is conveyed through mains.

The only way in which the velocity of flow in mains can be utilized with a high efficiency is by means of a turbine.

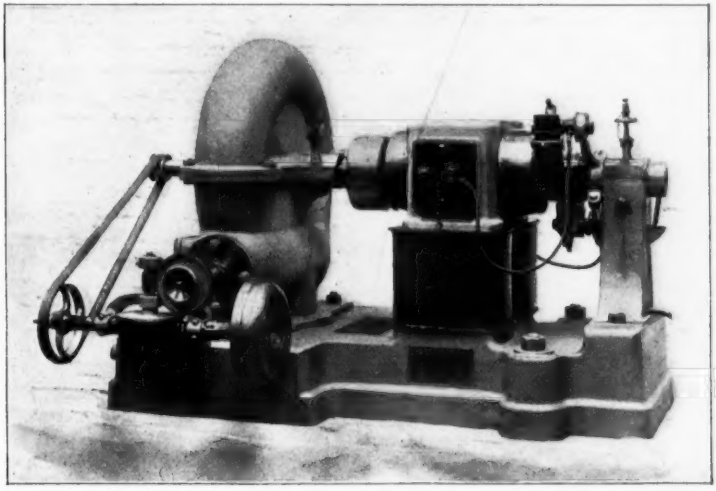


FIG. 8. 18-INCH PELTON MOTOR DRIVING DYNAMO FOR 50 16-C. P. INCANDESCENT LAMPS.

The subject of turbines is very interesting, and there is considerable literature on the subject. When well designed and constructed, turbines give the high efficiency of about 80 per cent., irrespective of the particular type. When using high-pressure water, however, the impulse or Girard turbine is the only form which will give anything like this efficiency. The velocity of flow due to a pressure of only 750 pounds per square inch is 320 feet per second, and there is much difficulty in dealing with so high a velocity. The well-known Pelton wheel, which may be considered a sort of double Girard turbine, has been almost the only one used for pressures of 700 pounds per square inch and upward. In the Pelton wheel a

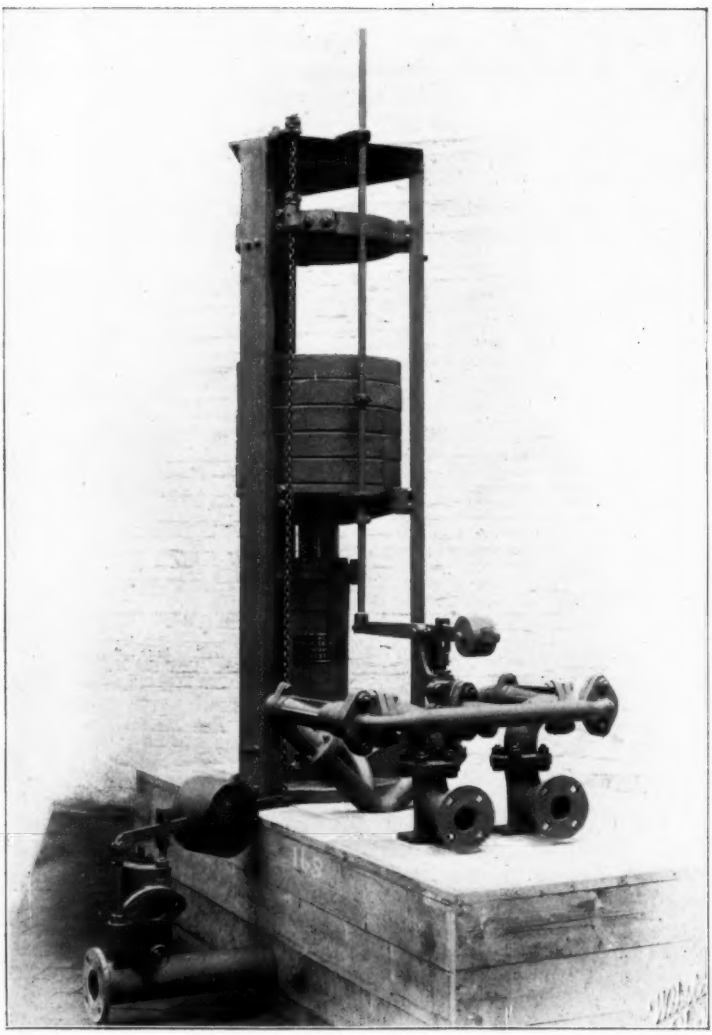


FIG. 9. AUTOMATIC WATER-SUPPLY APPARATUS FOR FIRE PROTECTION.

jet of water from a nozzle is allowed to impinge upon a number of cups on the periphery of the wheel.

The circumferential velocity of the wheel must be half the velocity of the jet. In the case of 750 pounds pressure-water, this would be 160 feet per second. For small powers the wheel cannot be made of large diameter, and the revolutions must be from 1,500 to 2,000 per minute, while the size of nozzle to give one horse-power is only .072 of a square inch. It is thus impracticable to make high-pressure turbines for very small installations, and they can not be economically used for less than one-half horse-power at this pressure. In order to obtain the maximum efficiency, turbines must be run at or near their critical speed, and it is not at all an easy matter to govern them effectively when the jets are so small. It is required to enlarge or contract the jet with the variations in the load. In Fig. 8 is shown the governing apparatus as made by the Hydraulic Engineering Company. It works quite well if the variations in load are not very sudden, but will not control all variations. The combination of a Pelton wheel and dynamo is a very pretty one. The wheel and armature are mounted on the same spindle, and the dynamo is constructed to run at the critical speed of the wheel.

The combined efficiency of the apparatus is about 66 per cent. with an eighteen-inch wheel exerting ten horse-power. By this means, on a large scale, hydraulic power can be converted into electric current with a loss of 33 per cent. in the process. The electric motor can be used to work a high-pressure pump, and thus convert electricity into hydraulic power with a loss of 20 to 25 per cent., because a pump has a higher efficiency than a turbine. This is fortunate, as there are more cases in which it is desirable to use electrical power for pumping than hydraulic power for developing electricity. This has, of course, nothing to do with natural water-power. In such cases, with low pressures and large powers there is no difficulty in effecting the conversion of hydraulic to electric with an efficiency of 75 per cent.

The great facility with which electric power can be subdivided renders it better adapted than hydraulic power to the thousand and one small purposes for which power is required in towns and workshops. The cases in which it can be advantageous to use high-pressure hydraulic engines and turbines are comparatively limited when either gas or electric power is available, but the relative position of hydraulic power in this respect is not due to any inferiority in the economy of the production and distribution of the

power, but solely to the mechanical difficulties in the way of utilizing it to the fullest advantage for such purposes.

There is one other application of the energy of the velocity of high-pressure water flowing in a pipe which is of great utility and importance. This is the injector fire-hydrant, to which I have already incidentally referred. Hydraulic power has not been used for the extinction of fire to anything like the extent which might have been expected, or that was contemplated by the late Mr. Greathead when he introduced the injector hydrant. Nevertheless it has been slowly making its way in private installations where hydraulic power is available, and it is undoubtedly capable of rendering the greatest possible service in places like London, where the pressure in the ordinary water-mains is too low to make the common hydrants really effective. In the injector hydrants a small jet of high-pressure water playing into the center of the injector, which is also attached to the low-pressure mains, increases the flow in the latter and intensifies the pressure in the hose-pipe. The injector hydrant will also suck water from a tank in the same way as an ordinary pump. It is to be noted that the pressure in the hose can be anything that the hose is made to stand, nearly up to the limit of the high-pressure supply. If that supply is, say, 750 pounds per square inch, it is obvious that nearly as powerful a jet can be obtained at the top of the highest building as at the street level, or the jet can be applied many hundred yards away from the hydrant, substantially with equal effect as if it were near. For this reason fewer injector hydrants are required in the streets of a given area than when ordinary hydrants only are used. The apparatus shown in Fig. 9 is a device for rendering these injector hydrants automatic

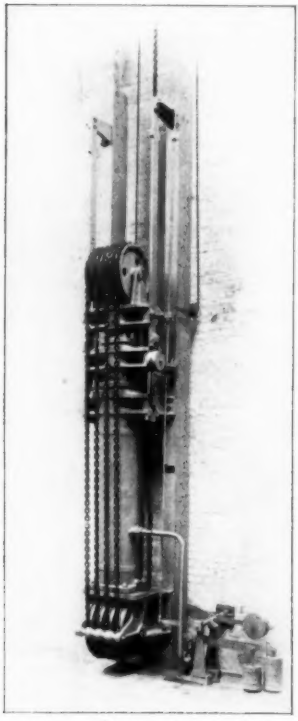


FIG. 10. DOUBLE POWER JIGGER.

on the outbreak of fire. It is primarily intended to work in connection with sprinkler systems in place of an automatic steam-pump, but it can also be used in connection with ordinary hose connections to maintain a given pressure in the fire-service, irrespective of the pressure in the ordinary water-supply mains in the street. The apparatus consists of one or more injectors connected with a controlling accumulator, which at once falls and starts the injector when any sprinkler or fire-hose nozzle begins to play. A slight leakage is provided for, so as to allow the accumulator to descend very slowly. It is then automatically raised, and the apparatus is thus always kept in working order.

The subject of hydraulic as of every other method of power distribution is a very large one, and it is quite impossible within the limits of an article to do justice to it; but I have, I think, said enough to show that for many purposes hydraulic power is mechanically the best form of energy and the most economical. That the views I have expressed here have not been unduly coloured is evidenced by the fact that in every town in which a public supply of hydraulic power has been established it has succeeded both mechanically and financially, notwithstanding the competition of all the other forms of energy. The experience in Manchester is particularly striking. The supply of electricity, of hydraulic power, and of gas are all in the hands of the corporation. The two former were started at the same time in 1894. The pumping-station was of considerable capacity, 1,200 horse-power. The electrical current is supplied for power-purposes at very low rates; nevertheless the demand for hydraulic power has so increased that a second station is being put down of equal capacity to the first. In London the demand for hydraulic power has increased more rapidly since electricity has been available for power-purposes than previously.

During the period from 1890 to 1893 the supply in London rose from 177,000,000 to 275,000,000 gallons in the year, while in 1897 it reached 524,000,000 gallons, and recently the supply has been at the rate of over 14,000,000 gallons in a week. From 1883, when the supply in London commenced, to 1893, about 1,750 hydraulic machines were connected to the mains, and the number is now about 3,700.

There is in the realm of the arts as in the realm of nature a struggle for existence always in progress, and in which the general law of the survival of the fittest is operative. The action of individuals and the fashion of the time may sometimes lead to great

prominence being given to one particular line of development, but in the long run the keen competition on every side and the necessity that requires the very best means to secure the industrial end in view will increase the continued use and development of all the various forms of energy which the bounty of nature and the skill of man have provided. Hydraulic power has been of the greatest value in industry in the past, and its future importance seems to be assured.

THE INFLUENCE OF ELECTRICITY UPON RAILWAY LOCOMOTION.

By B. H. Thwaite.

THE offspring of George Stephenson's creative intellect, the steam locomotive, is at last, after an unchallenged supremacy of half a century, threatened by a formidable rival, the electric traction or propulsion system. Very few, even amongst statisticians, grasp the extent of the influence that Stephenson's invention has had in altering and improving the conditions of modern civilised life. In Great Britain and Ireland alone the capital actually expended on railways and their rolling stock and other accessories is very considerably over one thousand millions sterling, and the undertakings employ some 400,000 persons. If we allow three dependents to each person we have the colossal figure of 1,600,000 souls supported by the great railway system in Great Britain and Ireland. The gross earnings in the British railway system nearly attain the figure representing the British annual State revenue.

With such a record, it is not too much to say that everyone is, or should be, personally interested in any new application or discovery in science that tends to improve in speed, safety, economy and comfort, the working of our railways.

At the period when Stephenson's Rocket was built, the design of this application of steam power for tractive or propelling purposes was very creditable to Stephenson's inventive genius, but it is recognised by thermodynamists that, great as have been the modifications and improvements in the steam locomotive, this instrument of applied science cannot be considered a satisfactory thermodynamic motor, and, as a means of developing power from heat, it is a long way behind the instruments that have been designed for other branches of engineering. The modern locomotive weighs, in certain instances in European practice, as much as the entire train of carriages, so that half the power it develops and half the fuel it burns is used up in effecting its own propulsion. An indictment against the modern locomotive may be formulated as follows:—

Because of the necessity of securing sufficient tractive effort and adequate structural strength, the steam locomotive becomes enormously heavy. This ponderous mass, covering only one-fifth of the

total wheel base of the train, has to be allowed for in calculating the proportions of the entire permanent way, and the bridges involved in such construction. The steam passenger locomotive has not only to employ half its own tractive force to move itself along a level line, but, in addition thereto, it has to carry part of its own weight (including its fuel and its water) over heavy gradients.

Despite the great structural strength of its own framework the vibration of the engineering structure constituting the ordinary locomotive can not be prevented. This, combined with the atmosphere charged with sand, dust, and ashes, and the cooling influence on the steam cylinder that follows its rapid movement *en route*, acts in a very prejudicial manner on the moving organs of the engine, and tends to make its only moderate mechanical efficiency comparatively short-lived. The high figures of maintenance of the steam locomotive compared with those associated with high class stationary engines are obviously the result of the peculiar conditions that are inseparably associated with the locomotive type of steam engine.

The greater part of the surface wear of the rails can be justly debited to the adhesion and abrasion of the steam locomotive driving-wheels; but there is a still greater defect in this legacy of Stephenson's genius, and that is the reciprocating principle by which the energy of the steam in the cylinder is transmitted to the crank-axle of the driving-wheel of the locomotive. Any one who has travelled on the foot-plate of a locomotive, or who has witnessed the starting of a steam locomotive, will have noticed the variable motion of the crank as the connecting-rod drives it over the dead center. These variations follow all round the circle, so that on each revolution of the driving-wheels, vibrations are set up over the entire structure of the locomotive and are the cause of the pulsations that vibrate and shake the ordinary train from one end to the other.

The open air conditions, under which the locomotive is compelled to work, are directly opposed to highly economic fuel-efficiency possibilities, because the locomotive steam generator is subjected to the worst possible characteristics of the atmosphere,—rain, snow, frost,—aggravated by the high velocity at which the locomotive runs. Only those who have seen the iron horse enter, after its day's run, the cleaning shed, from which it emerged in the morning clean and bright, can realise how almost unrecognisable (in its begrimed and dirty state) a locomotive becomes in a day's ordinary run.

The imperfection of the efficiency of fuel combustion in an

ordinary locomotive need not be accentuated. Any one who has the misfortune to be compelled to travel on the London Metropolitan Underground Railway recognises this fact, of which he is too often and too painfully reminded.

Could a more striking example be exhibited of the ignorance and contempt for hygienic science than is shewn by the condition of the tunnels of the Metropolitan Railways of London? Probably in no other city in the world would the characteristics of the atmosphere of the tunnel between, say, Praed Street, and King's Cross, be tolerated for one single week; a great part of the existence of this filthy attribute of the subterranean railway system in London may be charged to the imperfections of the steam locomotive.

This indictment could be lengthened, but enough has been stated to prove that, although we cannot fail to gratefully recognise the influence that George Stephenson's invention has exerted in ameliorating the conditions of the life of the industrious masses, it still in its high state of development possesses fundamental defects of a very serious nature.

The beneficent science of electricity graciously offers us a means for tractive and propulsion work, to move our train-loads of passengers or of merchandise, by which, in addition to the removal of all the serious disadvantages to a great degree inseparably associated with steam locomotive traction and already enumerated, we obtain qualifications that have made the sometimes irksome necessity of travelling a real pleasure, if not a liberal education.

An Anglo-Saxon may be pardoned the glow of pride he experiences when the name of our most illustrious Faraday is mentioned as the real inventor of the application of a science, that, in its mature growth, under the care of devoted students of electricity, has become a rival, and is in the long run destined to supersede the outcome of Stephenson's brilliant intellect, the steam locomotive.

In this new instance of applied science for the benefit of man, America leads the way. In the United States, within the last few years, many hundreds of electric road or tram railways have been equipped with the electric traction system of propulsion or haulage: in these railways there are over 30,000 electric locomotors and 15,000 track-miles of electric conductors.

In Europe, up to the early part of the year, over 100 electric railways have been completed, of a length approaching two thousand miles and having maximum gradients with smooth rails up to 10.5 per cent. and with rack rails up to 35 per cent.

Nearly every country in Europe is taking kindly to the new electric locomotor, Germany occupying the premier position. France is second, whilst England, at present, takes the third place. Once foremost in all applications of practical science for the advancement of humanity, England has now too often to take a minor and receding position. It is, however, some consolation to us, with our essentially constructive character, to know that in the practical introduction of the new electric locomotor system to what is distinctly ordinary railway practice, we have examples that may be justly dignified with the great title of pioneer systems. The author refers to the City and South London Railway and to the Liverpool Overhead Railway, both of which are actuated electrically. Then followed the first electric railway established by Sir W. Siemens and connecting Bessbrook to the Giant's Causeway in Ireland. The first-named electric railway (The South London) was opened for public traffic on December 18, 1890; the yearly mileage of each electro locomotor, in regular running, it is said, exceeds 30,000 miles. Between the stations, of only a mile apart, a speed of 25 miles an hour has been attained. There are gradients 1 in 30 on the line.

Sixteen trains leave each terminal every hour, proving the absolute reliability and uniform working of the system. In the first three years' working this pioneer electric railway has carried fifteen millions of passengers.

This railway, except for certain immature details unavoidable in pioneer movements, has been an undoubted success; it may further be said, taking into account its enormous passenger record, to be as safe as it is popular. The Liverpool Overhead Railway has been equally satisfactory in its results.

Although the two systems described can not be closely compared with long distance railway work, we are nevertheless able to draw fair parallels between steam-power short-distance railways in the States and the Overhead Railway at Liverpool. The two American lines are the Manhattan, and the Brooklyn Elevated Railroads.

The cost of coal per one ton mile on the Electric Overhead Railway at Liverpool equals..... 0.020d
The cost of coal per ton mile on the Manhattan Railway equals 0.029d
The same, Brooklyn Elevated Railway, equals..... 0.038d
The average cost equals..... 0.0355d
Advantage of electric railway equals 67 per cent.
The cost of supervision per one ton mile on the Electric Overhead Railway at Liverpool equals..... 0.014d

The same on the Manhattan Railway equals	0.036d
The same on the Brooklyn Railway equals	0.021d
The average cost equals	0.285d
Advantage of electric railway, therefore, equals 103.6 per cent.	
Total cost per ton mile, including supervision, motive power and train wages, coal, lubricants, stores, water, cleaning and repairs of rolling stock, on the Electric Overhead Railway at Liverpool, equals	0.1245d
The same on the Manhattan Railway equals	0.190d
The same on the Brooklyn Elevated Railway	0.152d
Average American steam locomotive practice equals	0.171d
Overall advantage of the electric system, 37.3 per cent.	

This superiority, striking as it is, does not do full justice to the electric system.

Taking the actual train mile in lieu of the ton mile, the inferiority of the steam system represented by the two American lines (the nearest in general working to the electric one with which they are compared) for coal consumption is as 16 is to 41.

This train mile comparison is merely put forward to show that the ton-mile factors of superiority of the electric system are greatly excelled by the train mile record of comparison.

In the electric railway system the generating stations are equipped with high-class steam-power triple-expansion and condensing engines, absorbing little more than 2 lbs. of coal per actual horse power of energy for one hour. The entire plant is under cover, and is well cared for and not exposed to direct outside atmospheric influences nor to dust and ashes, which play such havoc with the actuating organs of the steam locomotive. One engineer adequately supervises generating power plant that will drive several trains, and the skilled-labour saving is consequently very great.

There is, of course, the loss in electric energy conversion and in its transmission of, say, 30 per cent., but, even then, the fuel for power applied to the axle of the train will not be more than 2.6 lbs. of coal per horse-power hour of actual tractive effort. The very best all round practice on English and Continental steam locomotives may be taken at 3.3 lbs.; whilst probably 4.5 lbs. is nearer the average general expenditure for actual horse power of actual tractive effort.

And, as we know that the weight of the steam locomotive is roughly one-half of the load of the train it has to pull, consequently this fuel expenditure has to be doubled, or, for each (actual tractive effort) one horse-power per hour, there is an expenditure of from 6.6

to 9 lbs. of coal, whereas, with electric traction, when the motors are placed on the carriage axles so as to distribute and extend the area of wheel adhesion, the fuel expenditure for the same tractive effort should not exceed 2.6 lbs., or an advantage in fuel efficiency in favor of electric traction equal to from 153 per cent. to 247 per cent. The author will shew further on, how this fundamental advantage can be still further increased.

Even in the Overhead Railway at Liverpool where the system of power generation in its efficiency is not thermodynamically very high, the consumption per train-mile varies between a minimum of 16 lbs. and a maximum of 22½ lbs. Whereas, on our first-class steam-locomotive railways, probably an average of 41 lbs. of coal would be nearer the mark.

This latter comparison is, however, merely an approximate one, because it does not take the load into account.

It can be demonstrated that, for passenger and express trains, the same speed results can be obtained with electric traction at a lessened cost of energy over that required for a steam locomotion of some 60 per cent. The speed that could be obtained with the longest and heaviest train of electrically propelled freight cars, would be very great, and the length of the long freight train would not involve additional locomotives, as it often does at present,—straining the constructional strength of the permanent way. The distributed load of the self-propelled electric freight cars, however long the train might be, would only produce the normal vibration and strains to the bridges.

The constructional railway engineer will welcome the disappearance of the reciprocating steam locomotive, the distribution of the freight load, more or less evenly, the great reduction of shunting operations (which play havoc with the rolling stock, as well as destroy millions of dollars' worth of freight per annum). The removal of the effluent gases and exhaust steam from locomotives, will immensely reduce the effects of corrosion on the steel and iron bridges, and also will prevent the injurious effects that follow the contact of the condensed water from the exhaust upon the masonry and joints of stone and brick tunnels and bridge-work structures of our railways.

Certainly the displacement of the steam locomotive by self-contained electric locomotive freight cars will mean the reduction of the depreciation factor of our railways by at least one-half.

The rotary movement of the electric motor destroys at once

some of the disadvantages that are the inseparable associates of the reciprocating steam locomotive, and there is, indeed, hardly a limit to the speed that could be obtained with an electric motor-driven train, whereas it is well known that there is only a somewhat limited range of speed with reciprocating engines. Further, the speed of an electric train need not vary more than 5 per cent., whereas the speed of a heavy steam locomotive on ascending gradients is very greatly reduced, even as much as 70 per cent. on stiff gradients. By simply altering the strength of the magnetic field in electric driven trains, the same speed within 5 per cent. can be obtained, on the rising gradient, as on the level track.

It is recognised, by progressive and unprejudiced engineers, that the modern steam locomotive, judged purely on its merits and without bias in its favour because of its historic associations, is an imperfect thermodynamic machine. Quite recently an attempt has been made to re-organise its construction by using high-class compound engines, and a new form of steam generator,—coupled to a greater innovation still, that is, of transmission of the power to the driving wheels electrically, so as to obtain uniform rotative motion by the application of equal energy impulses all round the driving-wheel circle, the crank element being eliminated.

The success of this last-named innovation in overcoming the disadvantageous pulsations of the reciprocating movement was proved in the initial trials to be most striking and complete. The author immediately after the trial received a letter from Mr. Charles Brown, of Bâle, who was responsible for the general design of the steam engine part of this singular arrangement: "It may interest you to hear that the big electric locomotive was started last Monday. It runs wonderfully sweetly, the disturbing influences of the reciprocating masses being entirely eliminated. No counterweights on the driving wheels but a steady tangential pull on the tyres.

"You can hold a glass full of water, standing on the driving platform, without spilling a drop or even producing a ripple on the surface. The movement is even less than on a first-class Pullman."

This innovation comes too late. The remarkable efficiency of high-pressure electric transmission enables the power generating stations to be located in the positions adapted for obtaining the best results and at the lowest cost. There is no reason why both

the goods and the passenger trains on the Great Central (Eastern) Line, on the Midland, as well as on the other first-class railways should not be driven by power generated at one central power generating station located on the coal fields.

But, if this innovation is considered too startling, power generating stations could be established every fifty miles along the line, the energy currents being supplied in such a way that there would be no break of continuity of energy supply. Power gas generating stations of, say, 5,000 horse-power each could be installed fifty miles apart to satisfy the traffic requirements on their particular sections. It may here be noted, that with such power generating stations, the power would only be developed as required. There would not be any appreciable stand-by loss, which is a source of great waste in labour and fuel in existing steam locomotive systems. Such electric power generating stations would permit of the generation of energy, under the best conditions for securing maximum efficiency with the highest possible economy, and if such power energy were developed by the direct combustion of fuel in internal-combustion or gas engines, driven by gas generated from common and low-priced fuels from which the nitrogen, tar, and other hydro-carbons have been removed, there is no reason, if we take the value of the ammonia in its equivalent of fuel, why one tractive horse-power of energy for a period of one hour would not be obtained for three-quarters of a pound of coal. This, compared with the system of power-generation employed in the Liverpool Overhead Electric Railway is equivalent to a saving of 60 per cent. And this advantage would be added to the already calculated and magnificent proportions of the figures of superiority of the electric system over existing European steam locomotive systems.

Besides this fuel saving, the reduction in skilled labour costs represented by a great reduction in the staff of drivers and stokers would be very great,—because each steam locomotive must have its own engineer and stoker, whereas one man of similar competence could look after several stationary power-developing engines located in one generating station.

In some of the electric tram-roads of the United States, such as those of New York, Boston, Chicago, St. Louis, and Brooklyn, magnificent central power generating stations of as much as 100,000 indicated horse-power will provide all the energy for electric traction over miles of tramways. The smoothness of running, the

characteristic of rotative driving, has in some of the converted electric tramways of the United States, increased the passenger traffic by as much as 30 per cent.

In the extension of the Electric Railway System, the lightness of the train-wheel-base enables very great prime-cost economies to be effected, both in weight of permanent way and in bridge-work. For goods traffic, in order to obtain sufficient wheel adhesion to provide adequate tractive energy, and at the same time to avoid dead load other than paying traffic load, three or four special 30 to 50-ton goods waggons or freight cars of steel construction, equipped with electric motors, could be employed, in each long goods or freight train, so that the load, carried by these self-propelling waggons or cars, whilst providing the necessary tractive power and adhesion, would still be a paying one, and not represent so much dead loss as it does at present.

For shunting purposes at the junctions, some of the existing steam locomotives could be brought into service during the period of transition from steam to electricity, because the application of the electric system with certain simple precautions need not in the least interfere with the running of the steam locomotives over the line during the period of metamorphosis.

The conversion of the existing railway system would involve the laying down of the usual central conductor rail on the existing sleepers, and the provision of cars in which the motors are placed direct on to the axle. The momentum of the train would carry it over level crossings, but other and simple expedients are available under such conditions, so as to avoid all risk of life. That the electric system is safer than the steam locomotive is proved by comparative statistics.

The cost of a given unit of power plant, laid down at the generating stations, would be much less than that involved in the construction of high-class steam locomotives. The electric system applied to our great railways would enable very light and cheaply-constructed electric telpherage or other electric branches, single or double, overhead, or level railways to be laid down so as to feed the main branch and trunk lines with inland traffic, and thus meet in an ideal way the requirements demanded in Great Britain to satisfy the promoters of the new light railway bill.

The advantages that would accrue from the reduction of the working expenses, particularly in the maintenance of the rolling stock and permanent way, would, in itself, more than justify the

application of the electric system to the main trunk lines,—if not to the branch ones.

Terminal accumulator-charging stations would permit the electric railway system to provide electric energy to their own cabs and omnibuses, as well as to traffic waggons, and similar accumulator stations located along the line, fed from the electric energy mains, would permit the supply of energy to lorries, carts, and other vehicles for the transport of agricultural and other produce to the traffic-receiving stations; and the electric energy can also be sold to the railway customers.

An ideal line,—say for the transportation of large and heavy masses of raw and manufactured products between an industrial inland centre and a port, such as, for example, between Manchester and Liverpool, Leeds and Hull, Birmingham and Gloucester, Pittsburg and Philadelphia,—would be an electric freight-car line, each car to be of, say, 20- to 50-tons' capacity and equipped with its own motors, each bogey to be independently electrically driven. The freight trunk-line to run as direct as possible, but to have lighter branch electric railways that would take the raw, and bring back the finished, materials to and from the distributed factories of the industrial district. These goods would, by electric machinery, be rapidly transferred to or from the larger steel electric freight cars.

The electric power-generating stations would be distributed along the trunk-line in such a way as to electrically serve the branch-feeding light railways, and provide all the electric power for the port-terminal warehouses, and for lighting purposes as well. Such an application would carry the raw cotton from Liverpool and bring back the finished cotton at such a freight rate as could not fail to secure an extension, of an indefinable period, to the life of the great cotton industry of Lancashire, and the same application would be as beneficial to the woolen trade of Yorkshire, to the hardware trade of the Midlands and to the iron and steel trade of Pennsylvania. There is hardly any definable limit to the range of useful possibilities of the new system.

The application of the electric system to the London Underground Metropolitan District Railways should at once secure the removal of the sulphurous and carbonaceous elements in the atmosphere of the tunnels that make travelling on these railways a positive martyrdom; this defect is, no doubt, primarily responsible for the poor success of the Metropolitan Railways and for the abject financial failure of the Metropolitan District Railway.

Unfortunately the City and South London Electric Railway, infinitely superior as it is in the clearness of its atmosphere, can not be considered so satisfactory as a hygienist could desire,—as the atmosphere of this tunnel has occasionally associated with it an odour peculiar to organic decomposition, and therefore, what would have otherwise been considered an unqualified success, is marred by a serious imperfection for which there is no apparent excuse.

Were the Metropolitan Railway Companies to adopt electric traction and dispense with their locomotives, except for shunting and other auxiliary purposes, and employ electric arc illumination throughout the tunnel systems, lighting the carriages from the outside (each train switching on the light as it passed along a section,) and to employ the entire length of the side of the tunnels for a suitable decorative form of advertising, the increased patronage that would accrue from the splendidly attractive metamorphosis of the system would amply justify the expenditure. The underground railway system of London would be relieved of the stigma that its grimy and filthy association has given to it, and the hearts of the shareholders would be gladdened.

THE IRON INDUSTRY OF SWEDEN.

By David A. Louis.

IN a previous article the writer has drawn attention to the extensive mining and ore shipping operations that are being carried on in Swedish Lapland and it is intended in the present paper to endeavour to convey some idea of the great iron mining and iron and steel making industry that flourishes in central Sweden; that very ancient home of these enterprises, some of which can be traced far back into the hazy periods of the pre-middle ages.

The sketch map Fig. 1, sets forth the area referred to and in it are the great ore fields, with the horizontal extent of the ore deposits in each expressed in square yards; Grängesberg, 108,000; Norberg, 36,000; Dannemora, 14,700; Striberg, 11,050; Persberg, 8,550; Stripa, 7,200; Kantorp, 7,200; Nordmark, 6,000; Strassa, 5,640; Pershyttan, 3,840; Finmossan, 3,480; Dalkarlsberg, 3,444; Sköttgrufvan, 3,336; Bispberg, 2,400, and others of lesser extent, making an aggregate ore area of considerably more than 45½ acres. In talking of the iron ore deposits of Sweden we must, however, remember the great deposits north of the area here depicted and previously referred to, and the great ore deposit to the south at Taberg in Imaland with an ore area of 312,000 square yards. The Taberg marked on the map, Fig. 1, is in Wermland and is remarkable for having the deepest workings of all Swedish iron mines, the depth reached however is only 1,200 feet; so Sweden although remarkable for great iron mines is not characterised by deep ones; the next deepest mine is 1,100 feet deep and is at Dalkarlsberg. All the other iron mines in Sweden are much shallower; in fact moderation, not exhaustion, is the keynote of Swedish mining policy.

Some idea of the productiveness of these mining districts may therefore be gathered from the following tonnages of production given roundly, because as yet the writer does not know the results of last year's activity; Grängesberg, 660,000; Norberg, 140,000; Dannemora, 50,000; Striberg, 40,000; Persberg, Stripa, Sköttgrufvan and Dalkarlsberg between 35,000 and 25,000; the rest producing less than 20,000 tons a year.

These iron ore deposits occur in archaean rocks as lenticular masses, and appear to be bedded; generally there are several such

masses together, as the writer pointed out is the case in connnection with the Gellivan deposits. The masses vary in size from a maximum thickness of 300 feet in the Grängesberg mines down to 30 or 40 feet, or even 6½ feet for such deposits are deemed worth working. The length of a chain of deposits is, however, very great in many instances; for example at Norberg the longitudinal extent is nearly 22,000 yards, at Grängesberg about 4,500 yards, at Riddarhyttan more than 3,800 yards and at Dannemora not far from 2,200 yards. The ores obtained are both magnetite and haematite and their character and that of the accompanying ganges may best be exhibited by quoting some of the

Name of Mine	Oxides of Iron			Manganic Oxide	Sulphur	Iron	Phosphorus	Silica	Alumina	Lime	Magnesia
	Ferric	Magnetic	Ferrous								
Bispberg	2.30	95 4		0.4	0.006	70.7	0 0045	0.4	0.1	1.4	0.3
Dalkarlsberg	51	29			trace	56.7	0.06	12.3	0 6	2.6	4.5
Dannemora, Middle Portion		71.7	0.7	2.27	0.038	53.5	0.003	9.3	1.5	5.2	5.6
Finmossan "Bruten"		79.6				57.7	0.01	8.5	4.3	3.3	3.8
Grängesberg North Part	73.5	14 8		0.04	trace	62.2	1.54	1.6	0 6	5.1	0.3
Kantorp "Nymans"	1.2	92		0 3	0.023	65.2	0.007	3.0	2.1	0.3	0.7
Norberg "Ostanmossgrufvan"		53.6	20.1	0.3	0.03	53.2	0.007	14.1	1.6	4.1	6.5
Nordmark "Nygrufvan"		68.6		0.6		49.6	0.01	16 0		6.4	5.8
Persberg "Storgrufvan"	55.2		23.8	0.2	0.02	57.2	0.0033	10 5	2.4	5 2	1.9
Riddarhyttan		75.6	5.0	0.6	0.06	58.6	0.006	10.8	3.6	1.4	2.5
Striberg Åsbobergsgrufvan	81 2	5 0		0.1	0.016	60.4	0.032	5.8	3.3	2.4	1.4
Ställberg		64.2	6.17	7.43	0.044	51.3	0.009	8.0	2.3	2.6	3.1
Tarberg Wermland		74.8		0.14		54.4	0.008	14.4	0.4	4.0	6.1

analytical results that have been published by Professor Nordenström.* The numbers are per cent.

These numbers give some idea of the diversity in character of the ores, obtained at various parts of the area under consideration, but it must be noted that there are some three hundred mines in the district and that the composition of the ore, even in the same mine varies to some extent and there is of course variation between one mine and another. But the general characters of the produce of each mine remain fairly constant, that is as regards the proportion, generally so

* *Journal Iron and Steel Institute*, Vol. II., 1898.

low, of phosphorus and sulphur, the amount of silica or lime or magnesia in the gangue, and the haematitic or magnetic character of the iron ore itself; which fact enables the manufacturers of the district to rely on the supply of ore for making the delicate blends necessary in producing the special brands of high class material for which each of them is celebrated. Hence it is that running round the iron works of Central Sweden, the produce of certain mines are observed to be particularly prized at particular works. For instance at Laxa at the time of the writer's visit they were using ore from

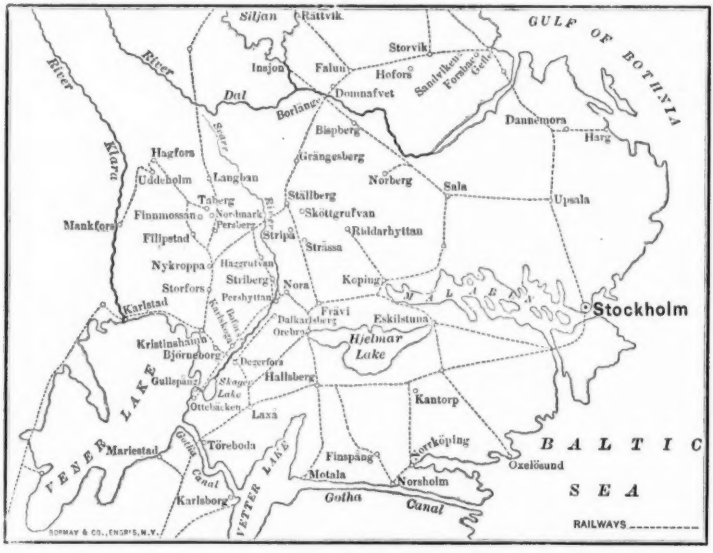


FIG. 1. SKETCH MAP OF SWEDISH IRON DISTRICTS.

Dalkarlsberg, Striberg, Kantorp and Sköttgrufvan. In many cases too the proprietors of the works are the largest shareholders in the mines from which they draw the ores they require. The efficient network of railways shown only in part in Fig. 1 facilitates distribution and renders this beneficial disposal of the produce of the mines possible. It may further be noticed that the railways not alone connect the mines with the works but they also connect both mines and works with great waterways, the Gotha canal, the Gulf of Bothnia, and the Baltic seaboard, and not alone does much of the manufactured product thus find an easy outlet to foreign shores but also

a great quantity of ore leaves Central Sweden to be used in other countries. This is particularly the case with the phosphatic ore of Grängesberg, which is shipped at Oxelösund on the Baltic Sea. Some of the mines are still worked open-cast, such a working is shown in Fig. 2. It represents an open-cast working at Grängesberg, which now extends below the surface level and is worked in stages; from each of which ore is trammeled to the base of a special shaft in the country tapping that level, thence it is wound to the surface; it is then taken along a gantry and tipped into railway wagons as shown in Fig. 3. The pyramidal structures shown to the left of Fig. 3 are the covered headgear of the shafts that serve the different levels. Where open-cast work is not applicable both overhand and underhand stoping are in vogue, the preference now-a-days being given to the former, with filling. Some of the stopes are very big—40 to 50 feet wide—and at Dannemora even 100 feet wide; for this reason and some others power drills have not made much headway in Sweden, but there seems little reason to doubt that the next few years will see a great alteration in this direction. Be that as it may, the hand drilling is excellent in spite of the fearful hardness of the work. Some stoping is still done without filling but no great proportion of the whole, however, vast underground caverns still open show how extensively this method of working has been employed in days gone by. A prominent feature of the mining districts of Central Sweden is the great number of deep gaping ravines and chasms, the remains of the old-time open-cast workings, with here and there some of the old covered winding gear still about. Another striking feature is the system of overhead travelling rods, painted red, used to convey power from the water-wheels to the pumping, hoisting, or other gear. Their day is doomed with the introduction of the electrical transmission of power, but now they are encountered, here and there, across country; always moving backwards and forwards and always groaning piteously as if aware of their doom. With regard to the treatment at the mines, by far the greater portion of the iron ore as it comes from the mines in Central Sweden is simply subjected to hand-picking before sending to market; but where this does not suffice the practices usual elsewhere are introduced, such as cobling with or without washing and picking; systematic screening and washing with or without crushing, and magnetic separation for the small stuff.

Turning now to the disposal of the ores, they as already stated, find their way either to neighboring works or to ports for export. In

the former case they are converted into metal on the spot and the general practice is as follows:—The raw ores are calcined in kilns heated by the blast furnace gases, and if necessary, the calcined ores are crushed. They are then stored in bins around the top of the blast furnace, each particular ore in its special bin. Here may be seen one of the most important operations in connection with the production of the various excellent brands of Swedish iron; that is the blending of the ores for the charge, and their distribution over the fuel in the furnace. The fuel, charcoal, is charged in direct from skips, then the ores are taken in regular order and stipulated quantities being most carefully weighed out in a scoop suspended from a steelyard that travels on a swinging crane-arm, which commands the whole top of the furnace, and by means of which each lot of ore or flux is distributed in a systematic fashion, that is quite astounding to watch. The mixture employed differs materially at various works and sometimes a great number of ingredients are included in the charge. At Hagfors for instance, at the top of the blast furnaces there were no fewer than thirteen bins with the quantity to be used marked on each; two of these were flux bins, and the rest were ore or cinder bins. The blast furnaces visited varied in construction and were about 50 feet in height with a diameter of about 7 feet at the throat, 10 feet at the boshes and 5 feet at the tuyeres, they are worked steadily to produce about 100 tons a week with a blast at about 1½ lb. pressure heated in pipe stoves to 200° C. for Lancashire pig and 300° to 400° C. for open hearth and Bessemer pig, and a consumption of about an average of 17 cwts. of charcoal per ton of iron produced. The iron is generally run into chills for pigs or into the ladles for Bessemerizing, but in some instances casting in sand is in practice, at Bofors, for instance.

A large portion of the output of pig is destined for conversion into wrought iron in the Lancashire hearth although the Walloon process and the puddling furnace are used to a slight extent, whilst the Bessemer and open-hearth processes claim their quota. The accompanying table, from Professor Akerman's paper,* shows the relative positions of these processes occupied at the beginning of last year.

It is a quaint and attractive sight to see a battery of these Lancashire hearths at work with the shingling going on under tilt hammers; it seems to take one back to legendary days, but there is no doubt that the work required by the Swedish ironworkers is well

* *Journal Iron and Steel Institute*, Vol. II., 1898.

done by this method. Moreover, Mr. Y. Lagerwall has invented a contrivance for breaking up the ball mechanically which not alone greatly increases the output per hearth but also diminishes the consumption of charcoal and loss of iron; according to Ackerman (loc. cit.) the weekly production per hearth is now 14 to 20 tons of blooms with a waste of 7 to 15 per cent. and a consumption of 2½ to 4 cubic meters of charcoal per ton of metal charged. Lagerwall's contrivance consists of a horizontal bar extending along and parallel with the front of the furnace fixed between two arms that work in bearings attached to the furnace. The arms are of such a length that the horizontal bar when up may be brought well above the fire opening and when down is at about the level of the table, so that when motion is given to the arms the horizontal bar takes a curvilinear course and approaches and recedes from the fire. Motion is transmitted to the arms by means of a link that connects one of the arms with the lower end of an eccentric rod working from overhead

		Metric tons.
Wrought iron	Lancashire	177,525
	Other charcoal hearth methods	10,188
	Puddle bars	1,919
	Total	189,632
Ingot iron and steel	Bessemer	107,670
	Open-hearth	165,836
	Total	273,515

DISPOSAL OF SWEDISH OUTPUT OF PIG IRON.

shafting, and to utilize the motions of this bar the rabbling-iron is provided with a lug which is placed so as to engage the bar at the commencement of its downward stroke; the tool in this way being carried forward into the fire, without scarcely any effort on the part of the man, who simply has to guide the implement, and the work is done not only with less expenditure of manual labour, but also more efficiently, effecting a saving of both time, fuel and metal. The ball is ultimately bloomed under a tilt hammer, rolled into billets and taken to the mill re-heating-furnace. The re-heating furnace mostly encountered in Central Sweden is Ekman's gas furnace; which is fired from one end, whilst the billets are charged in at the cooler end and gradually advanced to the hottest part, the working is commonly continuous, but re-heating furnaces with automatic firing devices and mechanical appliances were also seen. Some of the pig iron, however, is used for steel making and for Bessemer steel is taken directly from the blast furnace in molten

FIG. 2. ORE LOADING FROM THE SHAFT.

condition, and is worked in the usual way. When casting, however, the Casperson converter ladle is in some cases made use of. This consists of a small cylindrical ladle having at the side near the bottom a horizontal limb that can be attached to the mouth of the converter by means of lugs and wedges, the metal can then be poured direct into the moulds without the intervention of the ordinary ladle and crane. The advantage of this is the conservation of heat, which is of much importance; in this practice however the hole is fixed and therefore the ingot moulds are arranged in a turntable and brought up in succession. Swedish open-hearth practice is generally much the same as elsewhere with slight variations. At the Hagfors works of the Uddeholms Aktiebolag, for instance, the ladle was provided with an electric motor and ran on overhead lines, below which the moulds were hung on small train trolleys to be filled two at a time.

In the various Swedish mills visited, all kinds and sizes of rolls were to be seen; two high, three high, universal, reversible and tube mills. They were in a few cases operated by steam, in others by water-power; each train of rolls being sometimes provided with its own turbine, as at the Degerfors Steel Works, other times an engine being used to give the motion, and in some cases electrical

transmission has been introduced. Both hot and cold rolling are to be seen in central Sweden, the latter for instance at Sandviken and at Munkfors, the former at all works. Amongst the products of the works are both pig and ingot metal, bars, rods, plates, sheets, hoops, hollow blooms for weldless tubes, and the tubes themselves; tires, nail rods and nails, wire rods and wire, umbrella ribs, bicycle spokes, springs, saw blades, wood screws, horseshoe nails, and superior qualities of steel of all tempers for special purposes. The Swedish iron and steel manufacturers are keenly alive to adapting their practice to the requirements of the times and the insight into their practice obtained during this recent visit to their works producing the various objects just enumerated, clearly demonstrated that not alone do they appreciate but also readily avail themselves of the experience and discoveries of other countries to achieve their ends. They utilise liberally and to a large extent the appliances produced in other countries, therefore splendid examples of machinery and machine tools from America, Germany and England, were constantly encountered in many of the various places visited. These included: The Gängesberg mines; the Domnafvet iron works; Falun mines; the Hofors iron and steel works; the Sand-

FIG. 3. GENERAL VIEW FROM NORTH OF BERGSBO MINE.

viken steel works; the Forsbacka steel works; the Skutskär saw mills and cellulose factory, and the Dannemora mines of one group; and by the other group: The Laxa iron works and cellulose factory; the Degerfors steel works; the Uddeholms Aktiebolag works at Hagfors, Råde and Munkfors; the Storfors Bruks Aktiebolag at Nykroppa; the Persberg iron mines and the Bofors iron and steel works and the Bofors ordnance factory, the latter as exhibiting a special feature will be selected for some special notice. It may be noted as an example of the employment of foreign machinery that at Hagfors a specially fine display of American and

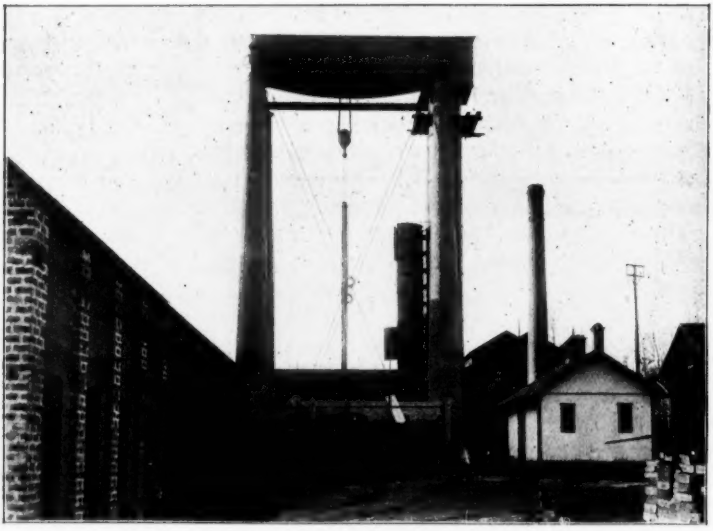


FIG. 4. BOFORS-GULLSPANG. CRANE AND TOWERS OVER HARDENING FURNACE.

German automatic nail making and screw cutting machinery was seen in operation; and further it must be observed that the Swedish folks themselves are by no means behind hand in developing this department of the iron and steel industry, and produce excellent machines of their own but, nevertheless, are as we have seen quite willing to recognize and employ the produce of foreign talent and genius.

As the conspicuous features of the mine of Central Sweden are the headgear, the chasms, and the travelling rods, so at the works are the waterpower, the blast furnace and calcining house and the

fuel-house. The last mentioned are well ventilated structures of great dimensions; their presence and magnitude is required owing to the fact that the fuel, charcoal, is so very bulky and moreover, can only be brought out of the woods in the winter and then only when there is snow for sleighing, so the works have to insure a provision of charcoal to cover three quarters of the yearly requirement. There being no coal at the iron centres of Sweden, charcoal is the only fuel used and this accounts for Sweden restricting itself to a comparatively small production of iron of high quality and its not competing in the heavy iron trades. In Sweden too the blast

FIG 5. HARDENING FURNACE IN ACTION.

furnaces and the calcining kilns are housed in, forming, whether housed together or separately, very conspicuous objects and with the coal-house and the connecting trestle inclines or bridges making a strikingly characteristic group of structures. The water-power is another special feature of the works of Central Sweden, and not alone does it compensate for the want of fuel but for that very reason the geographical position and distribution of the works is entirely due to this factor, and in times gone by, when only small water-powers could be dealt with only small works were possible. Now,

when larger water-powers can be controlled and utilised the movement is in the direction of the abandonment of small works and the centralisation of operations in large works, a policy that will be still further developed with the spread of electrical transmission, which has already found ardent advocates in some of the works visited. There is an excellent water power at Degerfors, which even in the driest seasons will supply 1,200 cubic feet of water per second with a fall of 25 feet, and a dam was being constructed to render a minimum of 4,000 h. p. over both at all times. Other works too have splendid water-powers and at Munkfors it takes the form of a fall which is both high and beautiful although not of such magnitude as Trollhättan.

All the works visited, with the exception of one, were working more or less on the lines just sketched out, and that one is no exception, so far as its production of pig and wrought iron are concerned, but it has struck out an independent line in connection with its open-hearth industry. The works referred to are those of Aktiebolaget Bofors-Gullspång. Its exceptional operations are the result of the development of the Terre Noire method of manufacture of cast steel ordnance, operations that are also conducted at Finspång which although included on the sketch map Fig. 1, was not visited by the writer.

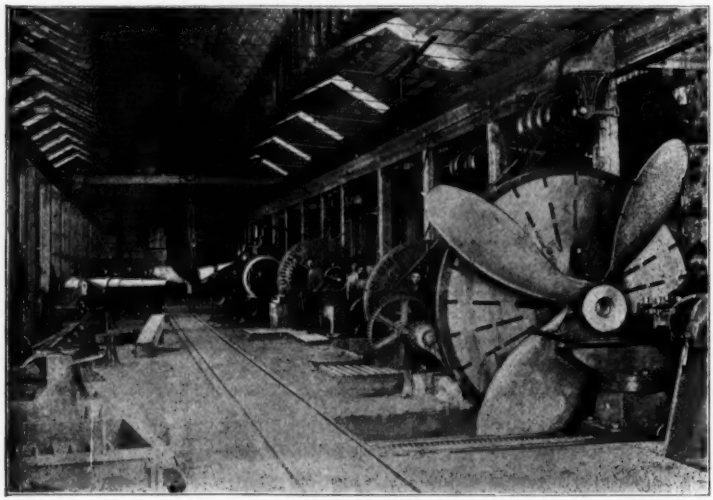


FIG. 6. BEFORS GULLSPANG. WEST SHOPS.

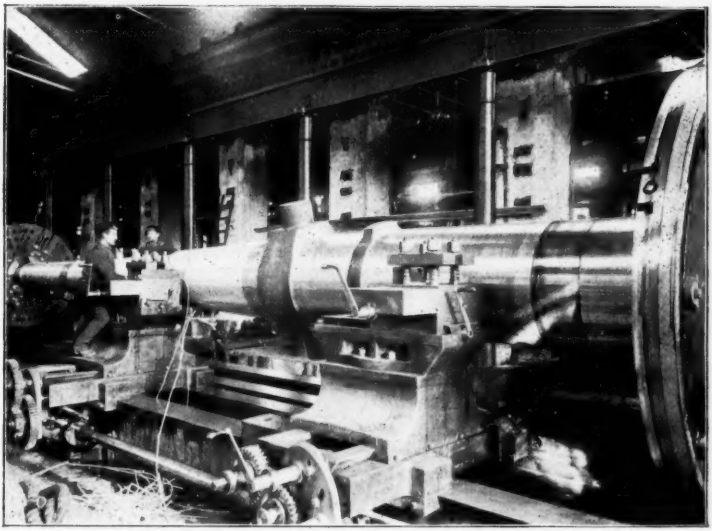


FIG. 7. BOFORS-GULLSPANG. GUN LATHE. CAPACITY FOR GUNS OF 30 CM. BORE. 50 CALIBRES.

It must be remembered that owing to the great care bestowed on the management of the blast furnaces, up to thirty years ago, all guns in Sweden were cast directly from the blast furnace, and the practice was simply discontinued owing to the difficulty of getting pig iron in sufficient quantity for the demands of the heavy guns now common.

The undertakings of Aktiebolaget Bofors-Gullspang are the present representatives of iron industries which have been in continuous activity since the fourth decade of the 17th century. They remained in comparative insignificance for two hundred and thirty years until under the ægis of the immediate predecessors of the present company considerable extensions were made and brought the works into some prominence. The present company was established in 1873 and has adopted and maintained a continuous career of progress and improvement, they now own works at Skjagersholm, Bofors, Björkborn, Björneborg and Gullspang most of which are shown on the sketch map Fig. 1, but of these only Bofors was visited. It is on the Nora-Karlskoga line, whilst the other title name is at the mouth of the river Gullspång that connects

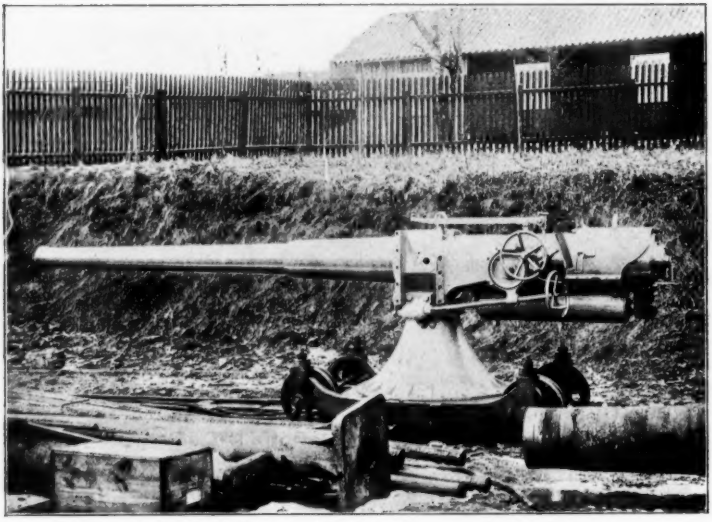


FIG. 8. BOFORS-GULLSPANG. 12 CM. 45 CALIBRE RAPID-FIRE CANNON.

Lake Skager with Lake Vener, navigation between the latter and Gottenburg or Stockholm being along the water courses connected by the Gotha Canal. The Bofors works at present comprises 1 blast furnace with calcining kiln; two open-hearth furnaces, one 10 and one 5 tons; thirteen Lancashire hearths for making charcoal blooms; five rolling mills for bars, rods, hoops and sheet; a steel foundry and an ordnance factory. The blast furnace is 50 feet high, 9 feet at the boshes and 4 feet in the crucible; the ores used are from Striberg, Haggrufvan and Persberg mines, and the output is 100 to 120 tons of pig a week, the consumption of charcoal being from 17 to 19 cwt. per ton of pig; which is converted into malleable iron in the Lancashire hearths and is worked up in the mill. The latter is kept busy on iron alone as practically all the steel is consumed in the foundry.

The steel works and foundry are of some size, as may be gathered from the fact that the latter is capable of accommodating very big work; a casting 16 metres long was made there and after cutting off 6 metres, as a head, was used for a 10-inch gun which is shown on the lathe in Fig. 7. All the well known precautions are taken to ensure a casting without blow holes. A casting was made in the

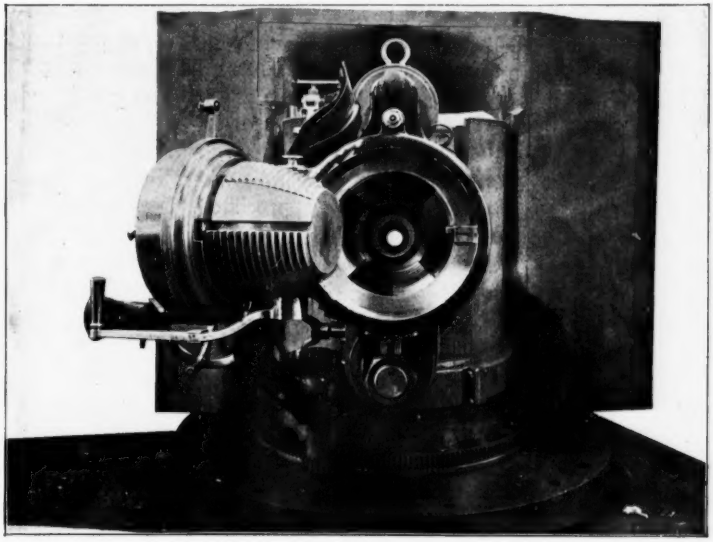


FIG. 9. BOFORS-GULLSPANG. 12 CM. RAPID-FIRE CANNON, SHOWING BREECH MECHANISM.

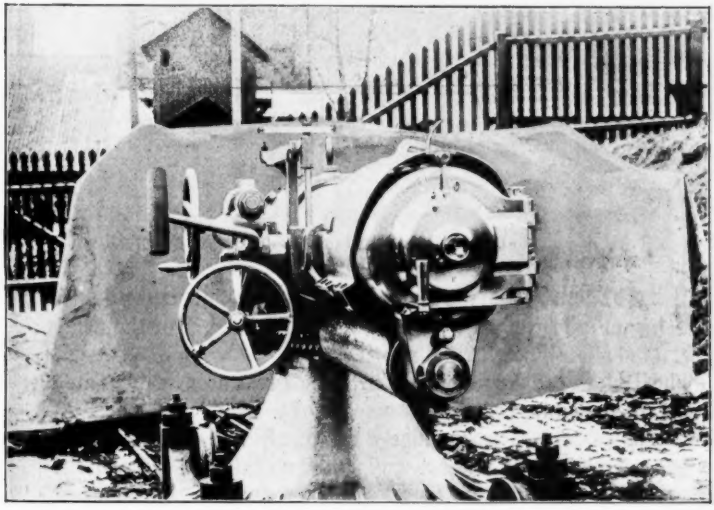


FIG. 10 BOFORS-GULLSPANG. 12 CM. RAPID-FIRE FIELD CANNON.

presence of the visitors; the furnace was tapped by means of a two-way spout, put into one and then into a second ladle, which was then manipulated by cranes, adjusted over the work and casting from both proceeded with simultaneously, the operation being completed with great expedition; in spite of the character of the object, which was a 12-ton ring for the base of a big gun. Two similar rings were seen, one in the yard and the other on a lathe where the excellence and magnitude of the work could be appreciated. Figs. 11 and 13 show other castings from this foundry; the latter is a stern post

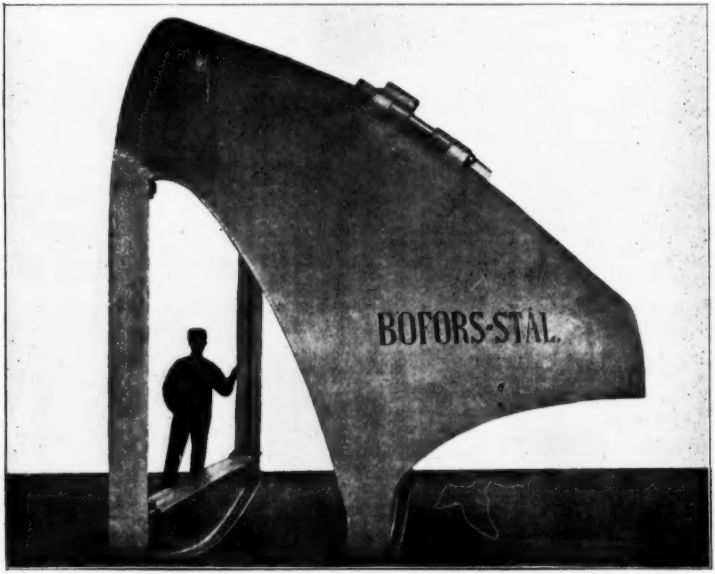


FIG. 11. BOFORS-GULLSPANG. PROTECTING SHIELD FOR 30.5 CM. CANNON. WEIGHT, 15 TONS.

and weighs over 12 tons; the former is an armour plate cast shield for a 12-inch gun and weighs 15 tons. Fig. 12 is the ram of the armour-clad "Thule" and weighs more than 9 tons.

The Bofors ordnance factory covers a great area with numerous shops, sheds and yards, all connected by a railway track. The shops are good structures nicely arranged, well lighted, and excellently equipped with lathes and other machinery. Fig. 6 shows one of the shops with a cast steel propeller slung in the background and another on the lathe in the foreground; whilst Fig. 7 furnishes

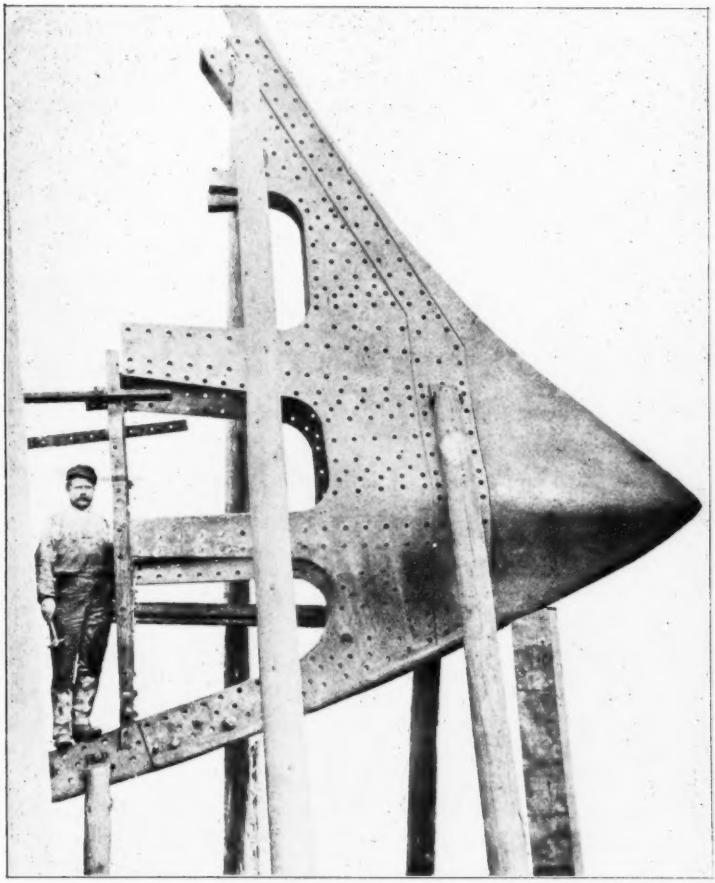


FIG 12. BOFORS-GULLSPANG. RAM FOR PROTECTED CRUISER THULE. WEIGHT, 9,170 KILOGRAMMES.

another example of the capabilities of these shops. Armour plates are cast at Bofors up to 20 tons in weight and are, if necessary, bent cold in a 1,000-ton hydraulic press to any desired curvature, an operation that was witnessed at the time of our visit on a plate 3½ inches thick. Projectiles are also made at Bofors; but undoubtedly the most prominent work of the ordnance factory is connected with guns. These they make of various calibres, that in Fig. 7 is a 10-

inch, whilst Figs. 8, 9 and 10 show 4¾-inch quick-firing guns. Fig. 8 is a side view of the 4¾-inch naval quick-firing gun of 45 calibres, which has the following data, these are given in metric quantities, inasmuch as they then accord with the registered measurements and gauges: Calibre, 120 millimetres; length of gun, 5,400 millimetres; number of grooves, 36; each one millimetre deep, 6.97 millimetres wide and separated by bands 3-5 millimetres wide; twist at breech, 60 calibres; at muzzle, 30 calibres; weight of gun, 2,800 kilos; weight of carriage, 1,700 kilos; capacity of bore and chamber,

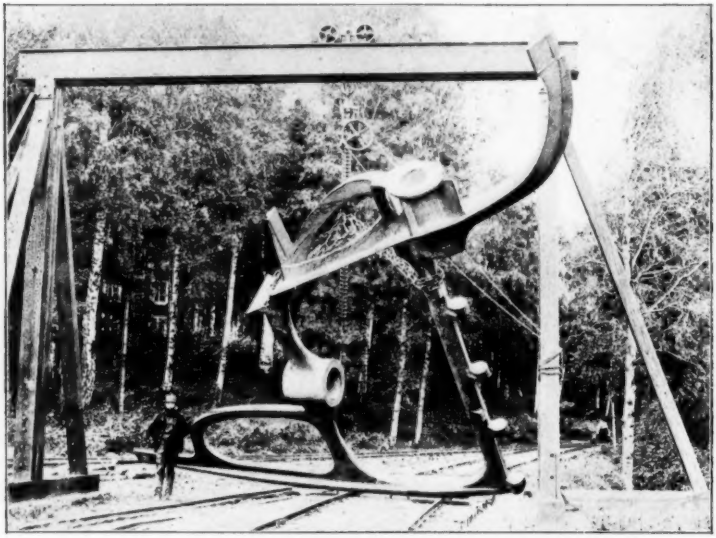


FIG. 13. BOFORS-GULLSPANG. STERN POST AND RUDDER FRAME FOR ICE-BREAKING BOAT. WEIGHT, 12,200 KILOGRAMMES.

60.6 litres; of cartridge case, 6.42 litrs; weight of projectile, 21 kilos; of charge, 4.20 kilos; capacity of cartridge case per kilo of powder, 1.53 litres; muzzle velocity, 793 metres; muzzle energy, total, 671 metric tons, per kilo of powder, 160 metric tons, per kilo of gun mass, 240 metre kilos; range with elevation of 17 degrees, 9,150 metres; velocity of projectile at 1,000 metres, 654 metres, at 2,000 metres, 534 metres; perforation of wrought iron at muzzle, 39 centimetres, at 1,000 metres, 30 centimetres, at 2,000 metres, 22 centimetres; length of recoil, 240 millimetres. Fig. 9 shows the breech view of the same calibre quick-firing gun in armour plated carriage,

it also shows the rifling, the cover and the breech mechanism. Fig. 10 shows the same calibre quick-firing field-gun with the breech closed. The spiral screw used in the closing gear has the advantage that it can be swung aside after turning it ⅛ of a turn on its axis, whereas a cylindrical screw requires many turns before it can be swung aside; the firing mechanism is contained in the cover, to which, however, space will not permit further reference. It may be added that the Bofors-Gullspang company also make the gun-carriages, limbers, implements, ammunition wagons, etc., and that Bofors guns, projectiles and armour plates have been submitted to the severest tests and have acquitted themselves well, as shown by published reports of such trials.

One of the most costly and at once the most imposing looking appliances connected with the Bofors ordnance factory is illustrated in Fig. 4; it is for re-heating and oil-tempering gun-tubes. The superstructure, as will be seen, consists of the brick columns some 70 feet high supporting a gantry upon which rests and works a 50 ton electric crane which is covered in; whilst extending some way up on the right hand side is the vertical re-heating furnace, the lower part of which is hidden by the house that is built around the top of the oil well situated beneath the centre position of the crane, and which is 50 feet deep. The re-heating furnace is provided with a series of doors, on the side facing the well, one of which is shown open in the figure; these serve for the admission and removal of the gun-tube and are closed during the heating. The heating is effected by gas firing from a number of gas nozzles provided for the purpose up the back of the furnace and the progress of the heating is followed by means of a mirror placed at an angle of 45 degrees in a pot below the furnace. The gun-tube is suspended in the furnace and moreover, generally manipulated with the greatest facility by means of the electrical crane. We had an opportunity of seeing it actually at work. The furnace was opened in our presence, the hot tube withdrawn brought over the well and then plunged into it; when the magnificent spectacle, but feebly depicted in Fig. 5, presented itself to our appreciative gaze, recalling to the writer an oil well on fire, and forming one of those striking factors that help to keep the memories of a visit green in one's mind. In years to come we shall be saying, Ah, yes! the place where we saw the fountain of fire and smoke in Sweden.

METHODS OF REMUNERATING LABOR.

By P. J. Darlington.

AT the present time engineering societies and manufacturers are giving a great deal of attention to discussions of "piece-work" and "premium" systems for machine building works in the employment of their workers. All of these systems are primarily for obtaining the lowest possible "wages cost" and "equipment cost" per piece produced, without loss in quality of product, excessive wear and tear of equipment or friction with the workers, and all involve offering extra pay for extra effort on the part of the worker.

The most important of these systems are (1) "Piece work," or the payment of a fixed price per piece produced, previously agreed upon between works and worker.

(2) "Piece rate," or the payment of a price per piece produced, depending upon the speed of production, in a manner previously agreed upon. Up to a specified number of pieces per hour, a low price per piece is paid, but when the speed of production has passed the specified point, the "piece-rate" is increased, not only for the remaining pieces, but for all thus far completed on that contract.

(3) The "Premium" system, in which the worker is paid a fixed rate per hour, until his speed of production has passed a specified point, after which he receives, on the additional pieces per hour, a small price per piece in addition.

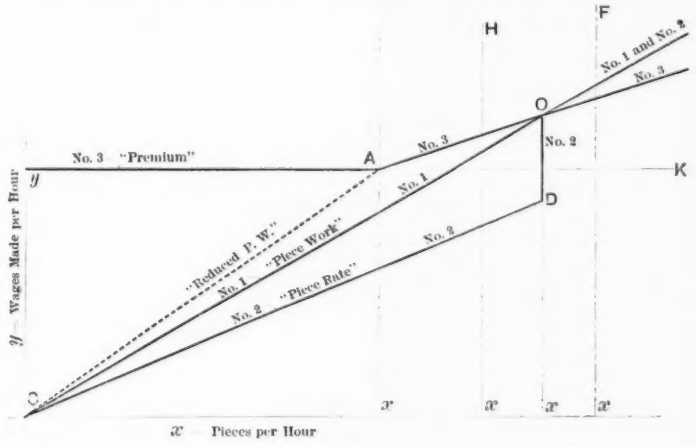
The accompanying diagrams on the basis of pieces produced per hour and wages made per hour, will clearly illustrate the three systems. In these diagrams the "Wages-cost" per piece at any output (X) and wages made (Y) is $\frac{Y}{X}$) or if a line be drawn from the centre (C) through any point on the diagram, the greater the angle which that line makes with the horizontal, the greater the "wages cost" per piece (tan. of angle) at that particular speed of production in that system.

The angle which the diagram itself makes with the horizontal at that selected point, represents the "immediate" incentive $\left(\frac{dy}{dx}\right)$ or reward offered the worker for increased speed of production, while the "total" incentive is the difference in his present wages per hour and that which appears to him attainable by increased effort.

In order to apply these diagrams to the comparison of the three systems, we may assume the following:

In a particular machine shop job, the point (A) represents the hourly output and "wages cost" under the old "day work" system. The point (O) represents an assumed attainable increase of speed of production, and the necessary increase of wages as incentive to procure it. Assuming that this point can be reached by either of the three systems, we draw all the diagrams through this point and we are now prepared to study the action of the different systems in producing equal results.

"Piece-work" (Diagram No. 1) has offered a uniform incentive to



PIECE WORK DIAGRAMS.

increased effort, represented by the angle of the straight line (C O) to the horizontal. This system not only offers an incentive to effort for increased speed of production beyond the old "day-work" speed represented by the line (A X), but also imposes a penalty should the speed of production fall below it (the diagram cuts the vertical (A X) below the point (A).

In this system the worker must reach a speed of production between the old "day-work" speed and the new "piece-work" speed before he will make even his old "day-rate" wages, this new speed being indicated by the value of (X) at which the diagram crosses the horizontal line through (A).

In "Piece Rate" (Diagram No. 2) the "immediate" incentive to effort is small, until an established high speed of production has been reached, at which time the "immediate" incentive becomes extreme (infinite rate of increase), (a vertical line on diagram), which means that a saving of a few minutes in his time on the job, when nearing the limit set, (either by great effort or by stealing a little time from another contract), may increase the worker's pay for that job perhaps several dollars, with perhaps some risk to quality of product or of damage to equipment. This is therefore an intensified "piece-work" system.

The penalty for failing to reach the limit (DX) and the reward for passing it are both very great, and it discourages very slow workers, but urges fast workers to very great efforts, provided the selected speed of production (DX) is correctly set at very near the ultimate capacity of the worker and tool. After passing this established speed, the diagram becomes identical with "piece-work," and the incentive the same (in the simplest form of the system).

In the "Premium" system (Diagram No. 3) there is no "immediate" incentive (horizontal line on diagram) until the worker has reached the old "day-work" limit (a low limit) of speed of production. As long as he refuses to pass that limit, either through discouragement, inability or laziness, he is working on "day-pay" and it makes no difference in his pay however little he produces. When he has reached the low limit, however, he has from that time forward an incentive represented by the angle of the line (AO) with the horizontal, which angle depends upon the premium factor allowed him, but which is necessarily less than the angle of the "piece-work" system, as is evident from the diagram.

We will now assume that, through additional skill of the worker, the speed of production has been increased beyond what was at first assumed to be the highest attainable, and that the production, by all three systems, has advanced to the line (F X).

It is now evident that the "wages cost" per piece on the "premium" system is less than on the other two, and this is one of the advantages claimed by the inventor of the "premium" system, that it reduces the "wages cost" per piece in a uniform and progressive manner, with increase of speed of production, and without the necessity of cutting the rates and so discouraging the worker.

If, however, the speed of production for any reason goes back from the original maximum, say to the line (H X), the "wages cost" per piece is least with the "piece-rate" system and greatest with the

"premium system," on account of the differences in the penalties imposed, and shown by the values of (Y), at which each diagram cuts line (H X).

It has thus far been assumed that each of the three systems has, in each case, brought about the same speed of production (and "equipment cost"). This was for the purpose of illustration, and it does not follow that one system may not attain a given speed of production in a much shorter time than another, or that it may not, in a given works, attain a final limit of much higher speed.

This analysis leads to the following conclusions:

The "Piece-work" system occupies a mean position as to the intensity of its action in increasing the speed of production.

It does not (without the cutting of rates) reduce the "wages cost" per piece progressively, but it does rapidly reduce the "equipment cost" per piece, or increase the amount of work produced by a given worker, machine and floor space.

In work of such a nature, or under such a management that the speed of production depends entirely upon increasing skill of the worker, and increases very rapidly with his experience or effort, there may come a time when his rate of wages becomes altogether too high, not only for competition in manufacture, but for good shop discipline.

In other words, the "piece-work" system is applicable where the ultimate capacity of a machine or worker can be determined before hand, by calculation, special observation or by experience, independently of the individual effort, skill or good will of the one worker.

The point (O) can then be determined with a considerable degree of certainty, at or near the maximum limit at which the work can be done with the equipment in use, and if the worker does not know how to reach that speed of production, he must be shown how to do it.

The "Piece-rate" system is an intensified "piece-work" system, in which it is even more necessary that the ultimate capacity of the machine be known at the commencement, as a mistake in the location of the line (O X), where his piece rate is changed, may result in totally discouraging the worker, or in making it a "piece-work" system, according as the limit has been set beyond the attainable, or at a too easily attainable speed of production. The system aims at particularly low "equipment cost" per piece (large output).

The "Premium system" has a less intense action even than the "piece-work" system, and is at the opposite extreme from the "piece-rate" system. The incentive is so slight that it cannot bring about the increased speed of production so quickly, or as great a final speed as

the other systems, nor does it automatically discourage and get rid of incompetent and slow workers, who must be dismissed by the old and most annoying methods.

It does automatically reduce "wages cost" per piece; also, the wages made per hour do not increase so rapidly and need not be cut so soon as in "piece-work," the reason for the last condition being, in part, that the incentive of the "premium" system is less, as shown by the smaller angle, and being a weaker system, it does not build up high rates so rapidly, and reduces loss by forfeit or gain.

If of any value whatever, it is in its application to that kind of work, or under that management in which the individual effort, skill, and good-will of the worker are almost entirely depended upon to show what increased speed of production can be reached. It would be difficult to imagine it applied to operating a screw machine and recording the cost of its product. While it reduces the "wages cost" per piece, it is less active in reducing the "equipment cost," because it offers a less incentive and is milder in its action.

From all the above it appears that the "piece-work" system is smooth and vigorous in its action, subjects the worker to a uniform and moderate incentive or penalty from morning till night and from the beginning to the end of the job, which is usually the safest and most economical method of operating at maximum capacity of tool and worker.

It requires a thorough draughting office system, that the drawings be complete, accurate, and corrected to date, and show all that is to be done on the piece. Also, a highly organized "piece-work" office and a system of estimates, observations, records, and comparisons, resulting in a definite knowledge of what length of time the work should take.

In ordinary works this result can be best obtained by the "subdivided" or "elementary" "piece-work" methods, supplemented by every available form of special observation, estimates on superficial area basis, and the exercise of ingenuity in tabulating estimates and records.

The "Piece-rate" system is one which urges the worker at a racing speed, against a high previously determined standard. It is extreme in its rewards and penalties, and is available only if there be uniformity in the work, and the most exact knowledge of how long each operation should take.

It can not be applied successfully to work which varies greatly through changing and unforeseen conditions, but in the turning of

shafting and the production of other uniform and standard work, there is not the least doubt that it can be made to obtain results more quickly and to a higher ultimate limit of speed of production than even the "piece-work" system. It is evidently unsatisfactory and dangerous in a weakly organized works with an inexperienced "piece-work" staff. It is probably the highest development of the piece-work art.

The "piece-rate" and "piece-work" systems are closely related, the one being a branch or special development of the other. A "piece-rate" ticket can be issued (properly stamped) from any "piece-work" office at any time.

The fundamental requirement of both is the knowledge beforehand of what length of time a given operation should take. They both start out by demanding the greatest speed of production of the machine operated by the cheapest possible worker.

The success of these systems depends almost entirely on the thoroughness and accuracy with which the value of operations can be determined, while this in turn depends upon the nature of the work, the organization of the draughting office and "piece-work" office, and upon the methods of dividing the operations into their elements and of recording the results of each ticket, so that the information can be available in various combinations of old elements for new work, for which rates may be required.

Any works operating the "piece-work" system can add the "piece-rate" modification to any of its departments and work the two side by side, because they use the same records and follow the same methods.

The "Premium" system is fundamentally different from "piece-work." It starts upon the basis of "day-work" management and increases the speed of production by offering premiums to the workers to induce them to show at what rate they can produce the work, instead of starting with the demand that the ultimate speed shall be attained.

It is a system of rewards without penalties, which is the basis of its only possible claim to favor with the workers, and is one cause of its weakness.

If the "premium" system has a value it is in work which cannot be analyzed, and whose value can not be previously determined. In other words, to that work which consists of a complicated set of operations which must be handled in the grouping in which they occur, or are dependent upon constantly changing conditions.

In the past this work has been frequently done by the "con-

tract" system, in which a contract price is put upon the job (as, for example, the assembling of a locomotive). This often resulted in the growth of the worker's wages beyond an allowable limit, which under this "premium" system, should be in a measure prevented, but by a reduction of incentive, and therefore a lower final speed of production and higher "equipment cost" per piece.

This reduction of intensity appears to the writer the only good purpose of the premium system, and even that is desirable only where low "wages cost is more important than low "equipment cost."

Even under such conditions, can not better results be obtained more easily by a "reduced piece-work" system, as follows? Place a "piece-work" ticket stamped across its face, "reduced after —— cents a definite rate per hour made (fixed for that class of work), the saving in "wages cost" shall be divided between the works and the worker. This would be accomplished in practice by issuing an ordinary "piece-work" ticket stamped across its face, "reduced after —— cents per hour."

In extending this ticket previous to its entry upon the "piece-work" records, order distributions, and pay-roll, the mean between "rate limit" and "'rate made" would be entered on all records as the "actual rate made" (assuming a 50 per cent. factor).

This gives the same diagram as the "premium system," excepting that a price per piece (see broken line) up to a fixed limit of "rate made," has replaced the "day-pay" in the "premium" system, and this new limit is not dependent upon the individual "day-pay" of any particular worker, and the "rate limit" can be set for an immediate increase of rate of production, in total disregard of old conditions. See diagram (C A O).

While this would accomplish the one practical purpose of the "premium" system, it is without its worst defects, as follows: It removes all complications arising from different and changing "day-rates" among different workers. It abolishes the full "day-rate" pay for a small day's output (behind which a worker can loaf indefinitely under the "premium" system) because it puts a severe penalty on slow production. It prevents a foreman's placing a high-priced worker on work intended for a cheap one, until he has obtained authority to so raise the cost of production.

It overcomes the greatest objection to the "premium system" (and every other mixture of "time-pay" and "piece-pay" in the same day's work) in preventing a worker charging time to "day-work" that has been spent on "piece-work," and thus receiving double pay for that

time and falsifying the records. It removes all the complication of an absurd system of individual day rates, and the continual jealousy and contention, resulting in annoyance to foreman and superintendent and injustice to the workers, due to a system of nominal "day-rates" on work which should be paid for on a basis of amount produced.

Finally, this new proposed system is a modification of the "piece-work" system and can be applied to any ticket at any time, and will work side by side with ordinary "piece-work," and does not introduce unnecessary complication and variable factors, which are inseparable from any combination of "piece-pay" and "time-pay" on the same ticket, and which complications prohibit nearly all of the secondary usefulness which distinguishes the more direct "piece-work" from all indirect systems.

Thus far this discussion has considered the direct effect of the different systems on the rate and cost of production and effect on workers. The secondary advantages of the "piece-work" system and its modifications, most of which are not shared by the "premium" system (or any other, involving a variable factor), are often, of themselves, of the highest value.

For example, in the "piece-work" system the estimated cost of a machine is the actual cost, excepting as modified in perhaps a few of its items, by directions and with the full knowledge of the superintendent. The cost of a machine is known before it is built and only confirmed by the actual returns as they come in.

The definite and certain value on each operation in the construction of a machine becomes as much a part of the data of that machine as are the drawings themselves, and as familiar to the manager and superintendent. The values of these operations form the subject matter of continual discussion among the designers, resulting in cheap and intelligently worked out designs and well informed designers.

The office methods of the "piece-work" system are the simplest and cheapest possible, for the results obtained, because it is the most direct method of using the means available, renders easy and exact the replacing of defective workmanship at the expense of the worker, the valuing of repair parts of machines, the pricing of finished or partly-finished parts of machines in stock, and all the many accounting and cost-keeping processes. This can not be equally true of any system whatever, in which variable factors enter into the cost of operations.

It is a popular error to believe that the modern "elementary"

"piece-work" system is an outgrowth of the old "contract" system, whereas it is absolutely opposed to it in principle and operation.

Much has been said about the relations of men and management in the application of "piece-work." The condemnation of "piece-work" in this connection has, in every case, been founded upon the assumption that "piece-work" prices are necessarily the result of a guess to start with, and continual cutting of rates without the use of tact or common sense. It is not necessary to discuss this in detail, for it is evident that the "piece-work" system is the most direct, easily handled and businesslike method of dealing with workers. It is on the universal principle of all fair dealing, and is of special value in this application, because it is so simple that every worker can understand it. In the "piece-work" system a worker is "in business for himself," a condition developing self-respect and calling out his best efforts.

The "piece-work" office methods and records, in the writer's opinion, should be free to the inspection and enquiry of the workers, should be absolutely without mystery and concealment, and reasons should be given and discussed when asked for. There is a difference of opinion on this last point, and the size of the works and consequent relations between the superintendent and the workers must be a factor in deciding it.

The cost and time required and the difficulty of establishing a modern "piece-work" system in any works depends upon the nature of the product, the general organization and the initial data and experience available. It requires considerable experience and judgment to ensure immediate success. The printed forms, the methods of keeping records and building up data, and all the minor details of the management of a "piece-work" office, are in the aggregate of great importance, and it is a system requiring considerable investment of thought and labor at the outset.

In the writer's opinion, any factory, the nature of whose product will warrant any system whatever, can profitably establish the "piece-work" system and use any of the "piece-work" modifications side by side from the same records, on those branches of the work to which each form seems best suited and side by side with day-work, where necessary, utilizing the "piece-work" form of ticket for subdividing, recording and making special observations on "day-work" orders.

On the basis assumed by the opponents of the "piece-work" systems, namely,—that the rates will be first guessed at and then indiscriminately cut, it is sure to be a failure, and this is not the correct or

modern idea of "piece-work" as a system, which calls for a consideration of human nature as well as tool capacity. Its immediate and its ultimate values to any manufacturing concern depend largely upon the kind of product. Where the work is all special and no two pieces similar, or built up of similar elementary members, the cost of "piece-work" (or any system) may be more than the value returned.

In the manufacture of electrical apparatus it would be almost impossible to compete with modern concerns without it, not only on account of the enormously reduced cost of production secured by it, but also its secondary usefulness in assisting the management. It would be difficult to imagine an indirect or a "day-work" system succeeding in this field, and, in the writer's opinion, it would be an absurdity to expect the "premium" system to succeed in it.

One or two writers have stated, or implied, that but few works are operating the "piece-work" system successfully. Any one acquainted with the machine manufacturing business in its various branches, must know that such a statement is absurd, and that but few successful works in the United States, manufacturing on the duplicate system, are, or can afford to be, without it.

The practical questions in connection with the "premium" system are:

Whether "what is worth doing at all is worth doing well."

Whether the "premium" system in itself is not a make-shift, necessitating greater complication, expense of handling and difficulty of installing, than the "piece-work" system, and very limited in the variety of work to which it can be applied profitably.

Whether every good purpose of the "premium" system can not be better accomplished by the more direct "piece-work" system with tickets modified, if necessary, into "piece-rate" or "reduced piece-work," or such other special forms as may be "invented" for special conditions.

Is not the "premium" system totally lacking in the features necessary for helping, organizing, and rendering automatic the management of a shop, and finally, is it not fundamentally on the wrong principle of mixing variable "time-pay" and fixed "piece-pay" in a complicated, purposeless and ineffective combination, giving a very low "total" incentive and a badly distributed "immediate" incentive in the production of work, and demanding expensive records, of very little secondary value in cost-keeping, designing, and separating good from inferior workers?

Does not the "premium" system demand some knowledge of how

quickly work should be done, and all the office machinery needed to obtain such knowledge?

Starting with that knowledge, however small, will not a "piece-work" system use it and increase it to much better advantage than any less direct system involving "day pay" or variable wages cost of product?

The modern tendency is to specialize the operations of manufacturing, and is towards the use of jigs, fixtures and special machines in the production of interchangeable and duplicate parts, all of which reduce the hand fitting and the time spent in assembling. In the best works the cutting tools are now ground on automatic tool grinders by one workman, while in many works the tool makers are given the supervision of setting jigs and fixtures and the starting of the cheaper grade of workers. The travelling crane has reduced the unforeseen delays and time lost in "waiting." All of these assist the introduction of piece-work, by reducing the variable factors, and they make it more beneficial when established.

In the writer's judgment, the "piece-work" system, with its various modifications, is a manufacturing system good for every class of work which can be systematized at all, and, moreover, its adoption is in accordance with, and progressing in the direction of, modern manufacturing practice. It is on a far broader foundation than the "premium" system, and is a long way from being the "abandoned experiment" that some writers claim. It is the most direct, simple, and, therefore, effective method of building up rapidly and getting the greatest value from a high (or any degree of) organization, wherever such is possible.

From both the manager's and engineer's point of view, it is of value at the start, naturally progressive (a building up process) and of almost unlimited possibilities in lowering the cost of production and increasing the organization, and rendering automatic the operation of a manufacturing works. Where it has failed, it has failed because it has been totally misunderstood and misapplied.

As to the published results attained in various systems, it should be remembered that a new and reduced cost over an old "day-work" cost, is of very little meaning. Almost any system will give better results than a total lack of system, as in "day-work." The improvement shown may mean a good system or a previous very poor "day-work" management.

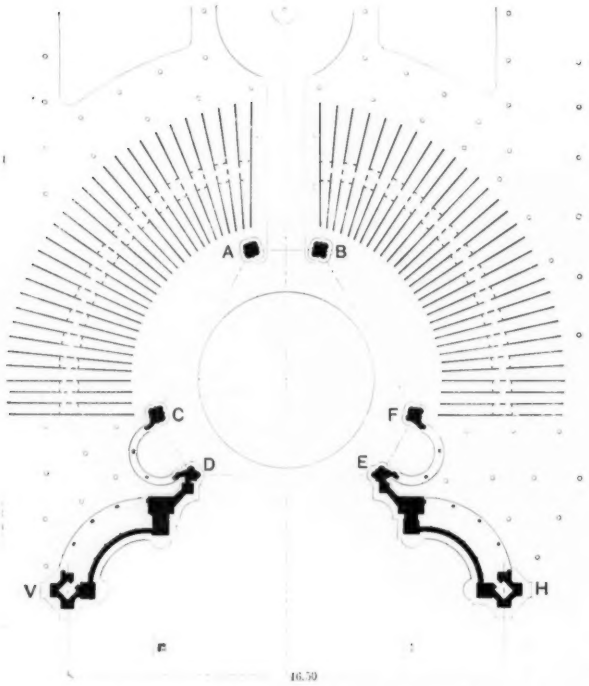
THE BUILDINGS OF THE PARIS EXPOSITION OF 1900.—I.

By Jacques Boyer.

THE conception of industrial expositions is of French origin, and dates back to the close of the last century. It was, in effect, under the initiative of Francois de Neufchateau, Minister of the Interior, that the first exposition was opened on the Champs-de-Mars in Paris, in 1798. A score of square metres then sufficed to house the various manufactured products of the one hundred and ten exhibitors taking part. No foreigners were permitted to exhibit, and the number of awards made by the jury was only 23. From 1801 to 1849, ten similar national exhibitions were held in Paris, but to England is due the merit of extending the scope of the original conception by inviting all nations to participate in the immense competition of 1851.

British and foreign producers to the number of 13,937 accepted the invitation, and the success was enormous. Shortly afterwards, emulating England's example and desiring to do even better, the Emperor Napoleon the Third inaugurated a Universal Exposition on May 15, 1855, in Paris which to the people of that day seemed the *ultima ratio* of its kind. After plans made by Cendrier, the architect of the Lyons Railway Company, a Palace of Industry was built which was also the first large metal framework building constructed on the Continent. Its graceful proportions, the light curves of its arches, the large and beautiful glass windows truly merited all the eulogies bestowed upon them. The area covered by the exposition buildings was 18 hectares, in which 24,000 exhibitors displayed the resources of the arts of peace. Five million visitors arrived from all parts of the globe, and returned fascinated by the result.

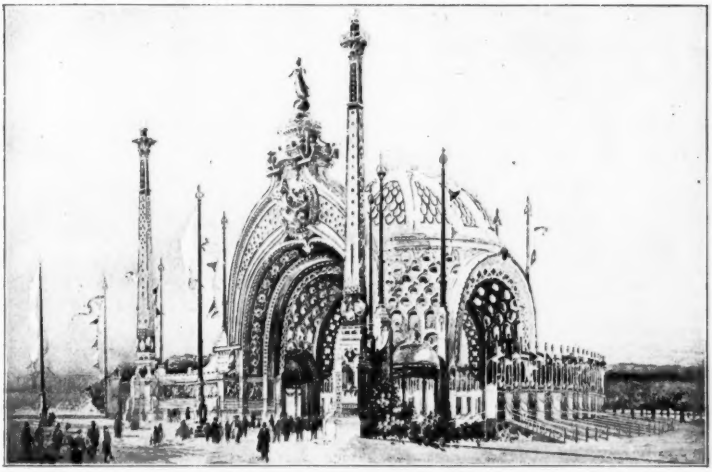
The start having been so successfully made, universal expositions followed one upon the other in all parts of the world. It is useless now to recall all the several steps which marked the great advance made in the march of human genius. They are within the memory of all, the last great stride, of the World's Fair at Chicago in point of the area occupied, leaving the Paris Exposition of 1889 far behind. Finally, at the dawn of the 20th century,



PLAN OF MAIN ENTRANCE TO THE EXPOSITION.

France has again deemed it useful to show the commercial, the industrial, the artistic progress of the civilized universe, and though the setting of this enterprise may not be as grandiose as that by Lake Michigan, the celebrated historical monuments of the Louvre, the Invalides, the Tuileries, etc., will frame it exceedingly well, and these associations will, so to speak, bind the memories of the past which they characterise and the aspirations of the future, which the objects exhibited are to enable us to perceive.

Let us therefore from an engineering standpoint go over the works where the many edifices that will temporarily house the rarest products of human activity are beginning to arise. For the purpose of our study, we shall suppose ourselves as started at the Place la Concorde, and shall indicate the prog-



THE MAIN ENTRANCE TO THE EXPOSITION.

ress and condition of the work during the months of March and April, 1899, introducing the more interesting features and briefly describing the more remarkable structures. Starting at the monumental entrance, we shall pass through the Champs Elysees, Champs de Mars, along the banks of the Seine to the Esplanade des Invalides.

Properly speaking, the exposition of 1889 had no principal entrance, but in 1900 a gigantic entrance will stand on the Place la Concorde at the end of the Quai de la Conference, a place where all the visitors arriving at the various railroad stations will necessarily congregate. This archway will have a height exceeding that of a six story house and the edifice will represent an open-work dome, recalling the Spanish-Arabic style of certain mosques. A principal arch of 18 metres span and 20 metres high will form its facade, the sides again consisting of smaller arches. To correct the rather ungraceful quasi-triangular shape of the structure, the lateral pillars and the pillars arising in the rear of the entrance way will be retrieved by smaller arches.

It is planned for a capacity of not fewer than 60,000 persons per hour through the ticket offices, which are placed in a semi-circle running around the back of the monumental entrance and extending from the left to the right pillar. By an ingenious disposition, adopted

by M. Binet, the architect, they are so contrived that not an inch of space will be lost. Under each ticket office an entrance will be excavated and while one part of the public may enter by ascending, the other by descending an incline will pass under the adjoining ticket office. In this way it was possible to double the number of such offices and to establish 58, instead of 28.

The monumental entrance will be constructed of light masonry and covered with enameled sheet iron. Its front arch is to be amplified by two other larger arches supporting a finial which represents the ship of the arms of the City of Paris, surmounted on its prow by

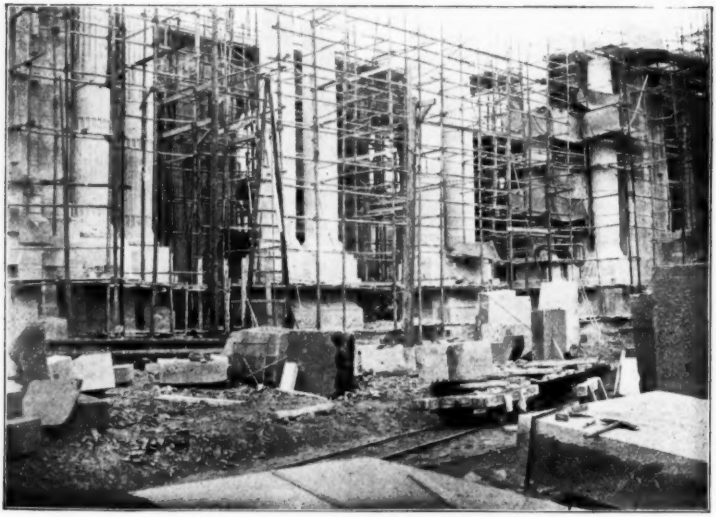
FAÇADE OF THE FINE ARTS BUILDING.

the Gallic Cock. On the summit of the arch, and rising to a height of 42 metres above the ground, a gigantic statue of Peace holding the traditional olive branch will be placed. To avoid the appearance of weakness at the base and facade of the arch, it will there be enlarged by two exedra highly ornamented with bas reliefs two metres in height, by the able hand of M. Guillot, and illustrating the history of human labor. The top of each ticket office will be decorated with ornamental motives representing the escutcheons of the principal cities of France, and above them again the flags of the divers nations of the universe will float. To the right and left of the main entrance way and adjoining the exedra, two minarets are to be erected, terminating in electric lights. They will stand about 46 metres apart and rise to a height of 44 metres. Sections of colored glass, covering the

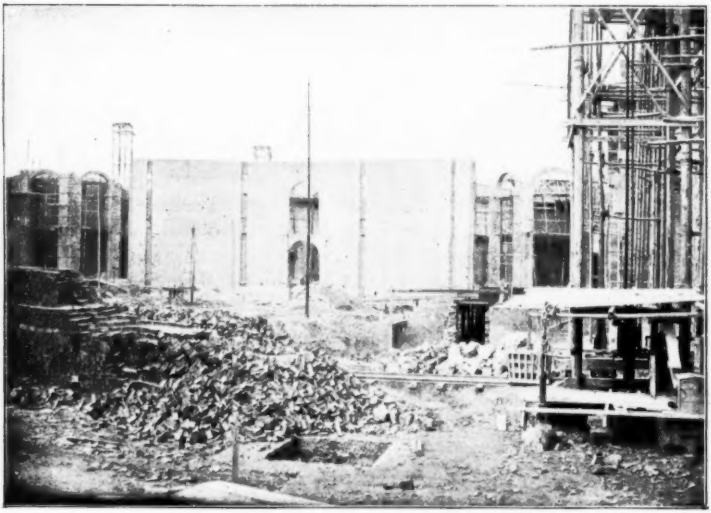
COLONNADE OF FINE ARTS BUILDING.
Showing tall crane tower.

dome, will shine in the sunlight, while at night the incandescent lights enclosed in them will cause them to sparkle in the luminous light rays thrown about from the tops of the minarets. Work on this structure was begun on December 23d last, and is not far advanced. The estimated cost of the grading and masonry work is 80,000 francs, while the metal framework and woodwork will require the additional expenditure of 109,000 francs.

The Fine Art Buildings form the climax of the proposed exposition scheme, and will in round numbers cost 20,000,000 francs, or one-third of the total expenditure. The proceedings had with reference to their construction were extremely interesting. After deciding first to demolish the old Palace of Industry, the Administration opened a competition, with the result, however, that the jury, M. Bouvard, Chief of Services d'Architecture presiding, found that none of the proposed projects could be executed as submitted. A collaboration among the leading competitors was then undertaken. To M. Viglanne was confided the interior portion of the grand building facing the Avenue, which on the right bank of the Seine prolongs the Alex-



WORK ON FAÇADE OF FINE ARTS BUILDING.



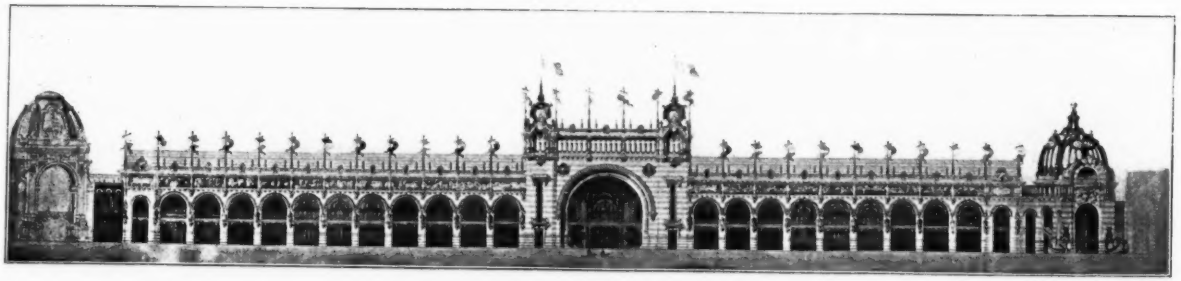
INTERIOR OF FINE ARTS BUILDING

FINE ARTS BUILDING AND STONE CUTTING YARD.

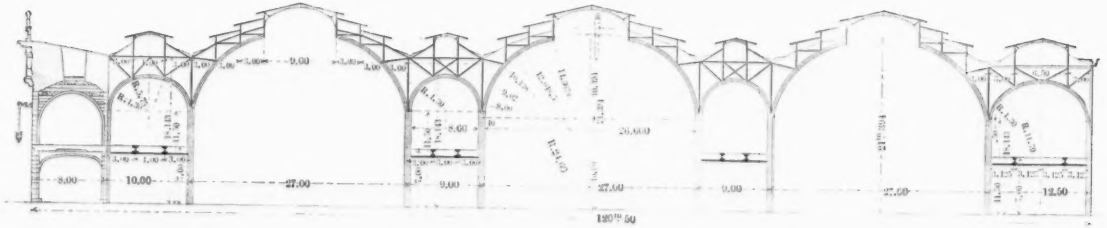
ander III Bridge. The intermediate portion was allotted to M. Louret, and to M. Thomas was given the portion bordering upon the Avenue Dantin. M. Girault, the only artist receiving an award in the two competitions was named architect in chief of the two buildings. A photograph of the final model approved by the Minister of Commerce is shown, and represents the front façade of the grand Fine Arts Building. As can readily be seen, the basement has been considerably lowered so that the proportions of the façade will not overpower those of the smaller building facing it. For similar reasons the peristyle contains but three entrances rather than one of a great height, proportionate to the size of the building. The glass roof is similarly lowered, and in order to avoid unfavorable effect, is masked by the attics of the exterior galleries. These promenades are very effectively arranged and the public will here be able to rest from the fatiguing promenades through the halls of the exposition. The low galleries of the nave will be lighted through the bays at the end of the galleries, while numerous stairways will afford visitors an easy access to the various halls. The curved ends on each side of the large hall will produce an excellent effect, as will also the prolongation of the axis towards the smaller hall. A monumental wrought-iron stairway will here lead the visitors into the adjoining edifice.

The following gives a general idea of the work progressing on this, the most important portion of the Exposition. In March, 1897, the foundations for the work were begun, and 17,000 cubic metres of cut stone, 10,000 cubic metres of ashlar and two million bricks were needed. For the lower courses, which are under the greatest pressure, and which are also subjected to the infiltrations from the soil, a very hard limestone found at Souppes, a village of the arrondissement of Fontainbleau (Seine-et Marne), is being used. The mouldings will be of the finer and softer stone quarried in Lerouville, and which is better adapted to the requirements of sculpture. The ordinary freestone, requiring no delicate decoration, comes from the quarries at Envilles and Villebois. This material is brought in barges on the Seine, to a landing near the Pont des Invalides, where a ten-ton crane erected on a suitable platform, lifts the blocks from the barges and places them on the cars of a narrow gauge railway. The loaded cars pass to the works by a tunnel built under the Quai de la Conference, and the stones are there unloaded on each side of the track by a traveling crane of 12 metres span. When needed, they are placed upon the bed of a diamond saw, and cut to the required dimensions. By the use of this apparatus the blocks are rapidly and cheaply prepared, the cost being only 1.50 francs per metre, as compared with 10 francs per metre for hand work. The cut stones are carted to the place where the work is progressing and there placed in position by means of steam cranes. One of the hoists has remarkable dimensions; it is in the form of an iron tower 40 metres high, the upper part only being movable, and has a lifting capacity of five tons. The mechanical appliances of this plant include a portable engine of 80 horse-power, operating the saws and driving two dynamos. These latter supply the current for the cranes and other hoisting appliances. The accompanying photographs were taken in March and April, 1899, and show the condition of the work on the façade. With exception of the superior entablature, the work was almost finished at that time, and the roof frames were beginning to be placed in April. There is shown also a view of the interior wall of the large hall taken from the side of the Avenue des Champs Elysees.

In order to house the enormous number of exhibits announced, the Administration had to procure as much space as possible for the buildings by reducing the area occupied by the gardens of the Champs-de-Mars. Furthermore, under direction of M. Bouvard, the administration of the exposition drew up a plan and general scheme to which each architect had to conform. Behind the Eiffel tower the



CIVIL ENGINEERING AND TRANSPORTATION BUILDING.



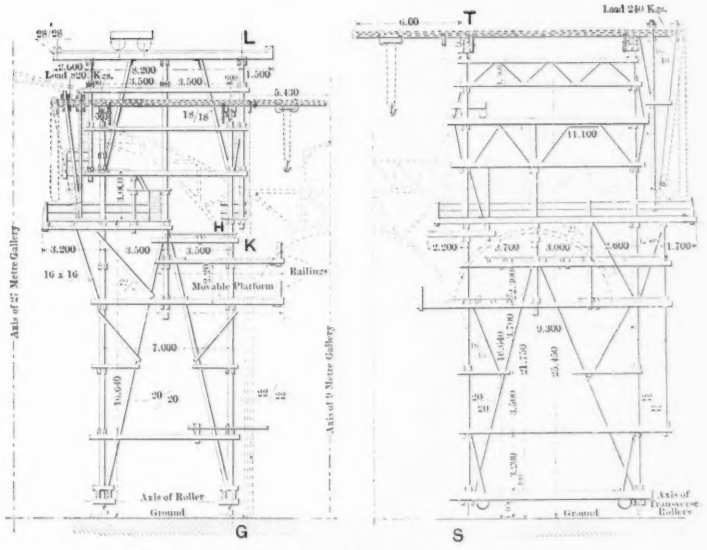
TRANSVERSE SECTION OF CIVIL ENGINEERING AND TRANSPORTATION BUILDING.

edifices were placed in two parallel rows. The Science and Arts Buildings, and those intended for Mining and Metallurgy, are only 16.50 metres high. Each of the following buildings increases in height until a height of 70 metres is reached in the Electricity Building.

It being impossible for us to enter into a detailed description of all the buildings on the Champs de Mars, we shall describe the most interesting and typical one among them, namely, the Civil Engineering and Transportation Building. This is the work of M. Hermant, a very able engineer, who constructed the French section of the Chicago (1893) and Brussels (1897) Expositions. Placed at right angles to the Seine, the Civil Engineering and Transportation Building is 281.40 metres long and 120.50 metres broad. It is enclosed on the river side by the Education Building and on the side of the Machinery Hall by the Chemistry Building. On the remaining side it borders upon the Avenue de Suffren. The framing will for the most part be so formed that curved lines will be used as much as possible. The cross section is the same for all three of the 27 metre galleries, these being suppported by two galleries of 9 metres with a nave of 12.50 metres in the rear, and one of 10 metres in front, these last being intended for restaurants. In this manner a sequence of halls will be secured extending from one end to the other of the Champs de Mars, and in addition thereto, a long gallery of 8 metres will run all along the front facade of the Civil Engineering Building. From an artistic point of view this will be the most interesting part of the monument. A light wood framing covered with staff will enable a massive effect to be produced and the upper section will be decorated by a frieze 2.75 metres high, representing in a series of reliefs, by the sculptor Allar, the history of transportation from the primitive cart of our ancestors to the automobiles of the present day.

A monumental entrance opening leads to a vestibule with an opening of 27 metres. This gallery will cross the edifice to the Avenue de Suffren and will form the grand exit. The building will be separated from the Education Building by a transept with an opening of 29.40 metres, ending, as will be seen, in a very pretty cupola of angles covered with transparent materials especially effective for the nightly illumination. At its further end the Civil Engineering Building joins that of the Chemical Industries by a frame of 8.85 metres span ending on the facade by glass panelling of more simple decoration.

The general plans of all the buildings on the Champs de Mars in-

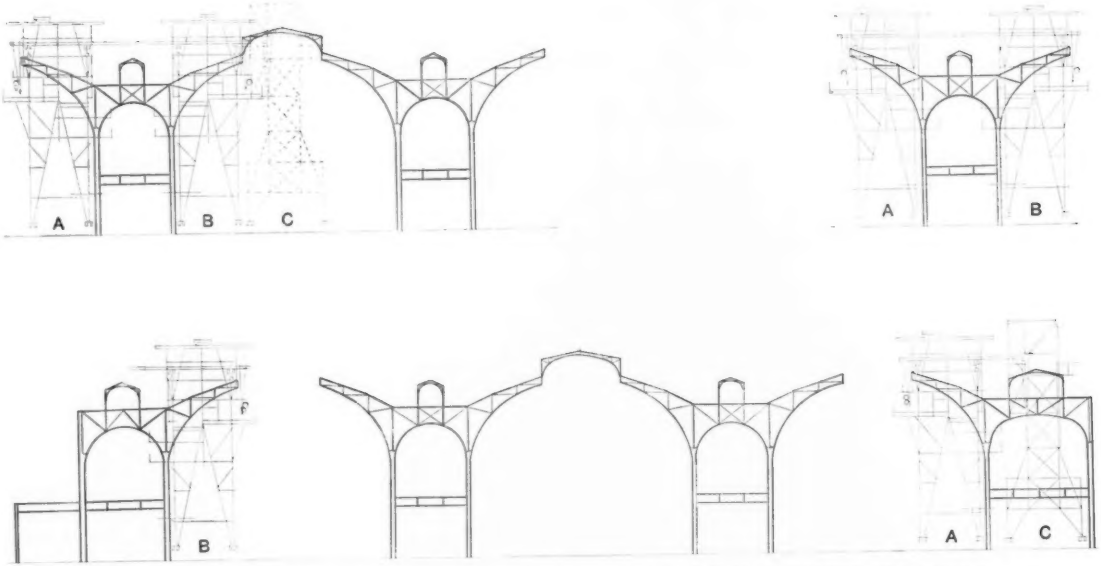


SCAFFOLDS USED FOR ERECTION OF CIVIL ENGINEERING BUILDING.

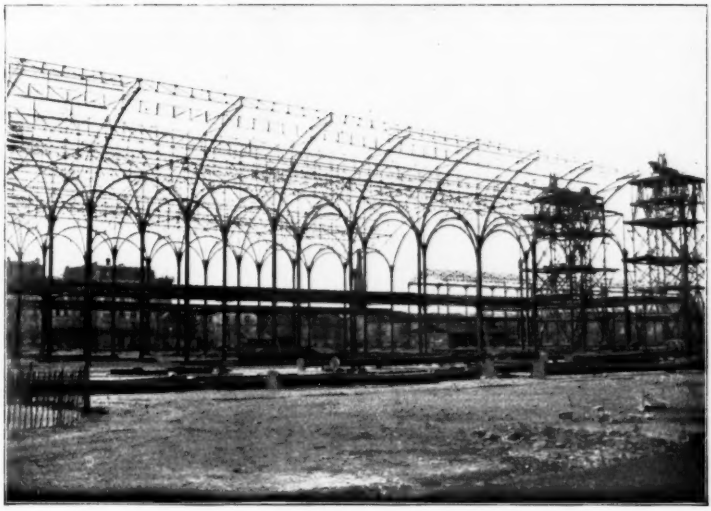
clude galleries at a height of 7 metres about the ground level, these galleries being placed in all the various naves except the large ones of 27 metres opening, in which the full height is left unbroken. These galleries are connected by bridges at various points, so that an uninterrupted passage is secured.

The characteristic feature of M. Hermant's work is a unique and constantly recurring type of frame, each element of which consists of two cantilever brackets abutting against a central beam, the whole structure resting on two pillars. This middle beam consists of a large truss and the roof of the 9, 10 and 12.50 metre naves. Each bracket is also a truss and together they form the roofs of the large galleries of 27 metres. A clerestory of graceful design covers the 9 metre span between the columns. The successive frames are connected by panels forming an arcade similar in appearance to the corresponding portions of the transverse members.

The erection of the frames was accomplished by means of two movable towers, upon which were placed overhung beams, carrying tracks for trolley-crabs, enabling the opposing cantilevers of the successive frames to be erected without the use of any fixed scaffolding beneath. The two towers were mounted on rollers carried upon rails



SCHEME OF ERECTION OF CIVIL ENGINEERING BUILDING. A, B, MAIN SCAFFOLDS; C, INTERMEDIATE SCAFFOLD.

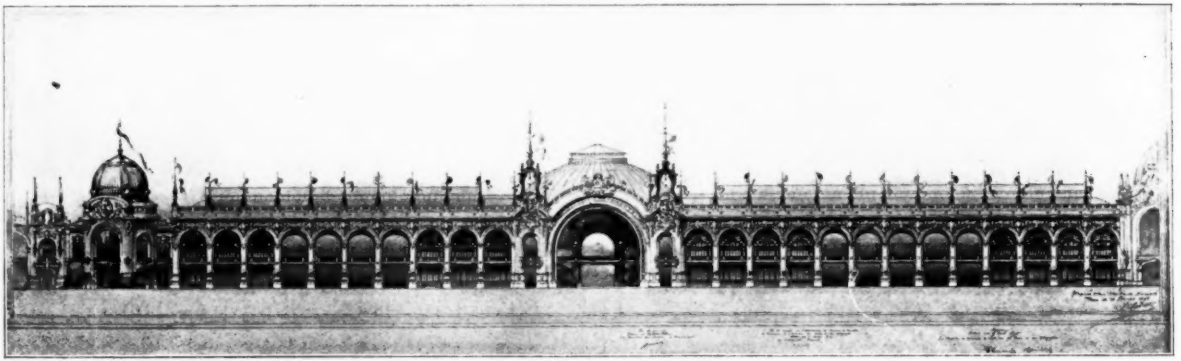


ERECTION OF THE CIVIL ENGINEERING BUILDING.

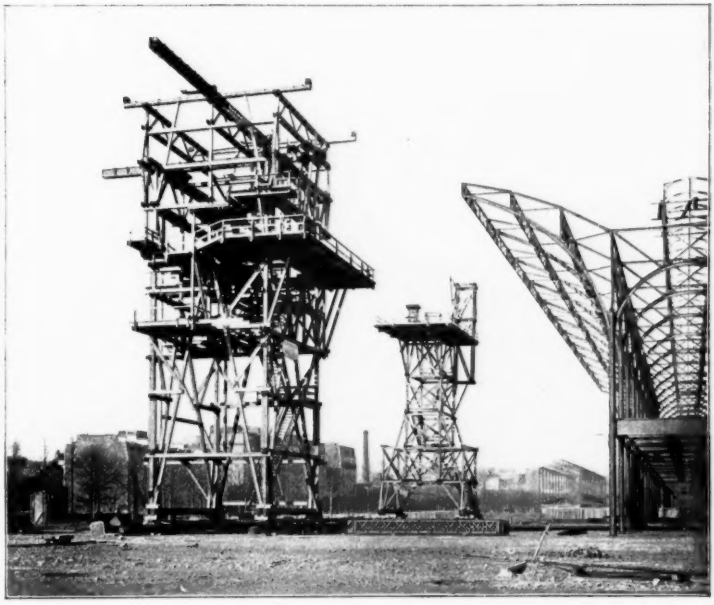
7 metres apart, and by means of a lever and ratchet gearing they could be moved along the length of the building as each successive frame was completed. The overhung beams upon which the trolleys were carried were at an elevation of 25 metres above the ground, and the rear ends of the beams carried counterbalances of 240 kilogrammes weight. Besides the main hoisting appliances on the tops of the towers, smaller platforms and cranes were used at lower levels independently of the upper work, for the purpose of erection of the lower portions of the frames.

As already stated, the façade of the Education Building will be connected by a rotunda with that of the Civil Engineering Building. Its construction has no distinct features to interest us, and it is progressing rapidly under the direction of its architect, M. Louis Sortais. The Mining and Metallurgy Building on the Avenue de la Bourdonnais, near the Eiffel tower, has its framework completed. The method of erection adopted was different from that employed for assembling the galleries of the Civil Engineering Building, the architect, M. Varcollier, using only a crane to put the members in place. If we may judge from the speed of execution, after comparing and following the respective operations for the

MINING AND METALLURGY BUILDING



BUILDING FOR TEXTILE INDUSTRIES.



THE ERECTING TOWERS OF THE CIVIL ENGINEERING BUILDING.

two buildings, this system, less complicated than the movable scaffolding, appears to us to be the preferable method.

Opposite the Civil Engineering Building we find the building dedicated to the Textile Industries. In length it will equal the Civil Engineering Building and will have a monumental entrance at the intersection of the avenues Rapp and Bourdonnais. The state of this work in March last is shown in our illustration. Two less important buildings are that dedicated to chemistry and that intended for materials of construction, both being built by the same architect, M. Paulin. They are placed to the right and left of the great cascade which is to be at the end of the Champ de Mars. The Electricity Building was described in the March number of THE ENGINEERING MAGAZINE. It is placed a little in front of the Machinery Hall of the exposition of 1889. In this corner of the Champ de Mars the work seems less advanced, the foundations have just been completed and in April the assembling of the framework began.

THE INDUSTRIAL SITUATION IN JAPAN.

By Lamar Lyndon.

MUCH has lately been written in various periodicals and trade and technical journals concerning things industrial in Japan, but, as a matter of fact, few, very few, of the articles which have recently appeared have presented actual facts, or correctly described the existing conditions. Travellers and manufacturers' representatives sojourning in the country for a few months by no means obtain a true conception of the character of the people, their business methods, their prejudices, and the conditions and environments that influence their industrial advancement. Even political officials who reside in the country for several years do not accurately grasp the situation, for the reason that they do not come personally in contact with the people whom the manufacturers desire to reach; as a result, consular reports are usually statistics from the customs offices, leavened a bit with general ideas and hearsay evidence.

This article is offered as an outline of the situation as it appears to the writer, whose views are based on an experience in various branches of engineering in Japan extending over nearly three years. At the outset it must be understood that the Japanese are great believers in themselves and their own abilities. Every individual of this race is a living, breathing marvel of self-confidence. There exists no doubt in their minds but that they can accomplish any engineering feat or construction; and repeated failures do not appear to shake their faith in themselves. The reason of this is their lack of experience. Their theoretical education is of a high order and they are generally like the newly graduated engineers who yearly come forth from technical schools, in that they are loaded to the muzzle with mathematics, theories and formulæ in which they put their unqualified faith and they lack the necessary experience to realize how theories and formulæ must be qualified in accordance with varying conditions. They do not have the opportunities of getting the practical knowledge and experience so necessary to successful engineering, and therefore remain theorists. Under the circumstances, they do remarkably well, but never attain to the foremost rank in engineering practice. It must, however, be considered that the industrial age of the Japanese is only about

twenty years, and their position in engineering affairs, though still an inferior one, is extraordinarily high for a race which has so recently entered the field.

One fault which is ever characteristic of the inexperienced is the tendency to purchase cheap machinery and supplies, and this fault is strongly marked in the Japanese. It is difficult to persuade a Japanese to pay more for a good machine than for an inferior one at a lower price, if neither is well known to him. He will, however, pay far more for a machine which he knows and which he has seen operate, even though a better machine be offered at a smaller cost. For this reason it is hard for new comers to dislodge those nations which have long been in the market and have the business already well in hand. If manufacturers wish to build up trade in Japan they must do as others have done—send representatives to the country. These representatives must go with a thorough knowledge of the machinery they propose to offer and be ready to meet any and all questions with both scientific and practical reasons for every detail of design and construction. The next best method to secure Japanese trade is for the manufacturer to place his interests in the hands of one of the good companies engaged in engineering business in Japan.

Labor-saving devices, the first cost of which is high, will not find any market in Japan no matter how desirable such machines might be for other countries where labor is expensive. The interest and depreciation on appliances of this nature will amount to more per annum than the actual cost of the labor they may save. The fact that machinists get about 50 cents per day and laborers only about 15 or 18 cents, should be considered when making up designs for equipments of various kinds, and unnecessary and expensive refinements avoided. In fact, extreme refinements are a positive disadvantage, as the attendance is hardly ever of the best, and is seldom good enough to keep a sensitive or complicated piece of mechanism in proper running order. Therefore a good, plain, simple machine at a low price, the operations of which are assisted by hand, is the best for the Japanese market.

It is true that many of the most extensive and complicated machines are sold to Japanese. These are purchased by the engineers who are theorists, and in the absence of any practice in their own country they follow implicitly the American, English or Continental practice regardless of its fitness, and with but little attention to local conditions. An instance might be cited in the experience of the

writer in contracting with a Japanese company for the sale of some large compound engines. The Japanese engineer of the company insisted upon having vertical engines, not for any mechanical or engineering reason, but because this type was selected by a New York company for the same class of work, and this engineer had seen a description of the New York plant in an American technical journal, and insisted on modelling his plant after it.

The engines in the New York plant had been specially designed to cover the least possible floor space, as they were installed in a locality where the cost of ground was incredibly high, and, furthermore, the plant was on a plot of ground surrounded by valuable buildings, so that increasing the floor space was impossible, and the problem was to get in as much power per square foot of area as practicable.

In the case of the Japanese plant there was ample room to extend on every side, land was cheap, and there was no earthly reason for the adoption of vertical engines. The writer made some calculations which he laid before the Japanese engineer and these showed that the excess of cost of vertical engines over horizontals for the same duty would be $11,500. The saving in floor space, allowing for a smaller building, reduced cost of ground, etc., amounted to $830, making it cheaper by $10,670 to use horizontal engines. It was useless to reason, however. The precedent set by the New York company was followed, and the vertical engines were installed.

All devices and refinements to reduce coal consumption are desirable. Japanese coal sells at from $2.50 to $4 per ton, and it is of a poor grade. In designing steam plants the writer never assumed more than 10,000 B. T. U. per pound of coal and believes that 9,500 is nearer the mark. This coal burns with a long flame, making high or long combustion chambers in boiler settings necessary to secure the greatest efficiency.

The favorite types of boilers in use are the Lancashire and Cornish, which are used almost exclusively. This is, of course, the result of following English practice. Very few American tubular boilers are at work in the country, though their low first cost will make them popular as soon as the Japanese discover that they are practically as satisfactory as the internally-fired types.

With the exception of the engines in the electrical plants—which are nearly all American made—the engines generally in use are English built, slow speed, with Corliss valve-gear, the dash pots being placed horizontally upon the side of the cylinders above the

rocking plate. The steam distribution, clearance, and consequently the economy per I. H. P. of these engines is practically the same as that of American Corliss engines; but the mechanical efficiency is lower and the steam consumption per brake H. P. larger.

In spite of these facts it is next to impossible to sell a steam plant alone. The reason of this is the continuance of the ancient practice of placing one order with a single firm for a complete shop or factory equipment including steam plant, machinery, shafting, pulleys, belting, and all transmissive appliances. Of all the large cotton and woolen mills which have been built in Japan, each was equipped complete by a single manufacturer, and as textile machinery is almost invariably purchased from English makers,—except silk machinery, which generally comes from France,— the steam plants are all composed of English engines, boilers, pumps and accessories.

Boilers are fed by means of vertical fly-wheel pumps, the valves being actuated by an eccentric on the shaft; the ordinary direct-acting type so much used in the United States, not finding favor in the eyes of English engineers, who furnish the plants. Economizers are nearly always installed.

In the last year or two the Japanese have begun to appreciate the advisability of buying each class of machines or appliances forming the component parts of a complete installation, from builders who are specialists in the respective lines. Within a few years we may, therefore, expect to see orders divided, just as they are in the United States, the contracts for boilers, engines, pumps, power transmission, and the various machines being placed with different makers.

In this connection it is well to note that all screw threads cut in Japanese shops are Whitworth standard. This applies to pipe fittings, machine screws, and everything else.

Blessings, silent and far away, but none the less heartfelt, will be invoked upon the head of the American manufacturer who has the foresight to cut Whitworth threads on machines intended for Japan, wherever other parts or connections, made in that country, are to be fitted thereto. Some very annoying experiences have fallen to the lot of the writer, owing to the impossibility to get threads cut in Japan to United States standard. One one occasion in erecting a steam plant with piping cut in Yokohama, it was necessary to take off and discard the flanges on the heater, separator and engine, and cast, finish and tap new ones, because those sent on their respective openings were tapped to United States standard.

The universally low grade of machine tools found in Japanese ma-

chine shops immediately attracts the attention of the American engineer. They are built in England or Germany, and are sold at prices that represent low figures for their tools but rather high prices for castings. Castings they are, and hardly anything more. They are finished with about as much accuracy as a pile driver, and will do work any way but properly. Cut gears are seldom seen; all lathe, planer, and drill press gears are cast; lumps and fins are removed with a cold chisel and finished off with a file. A nice job of screw-cutting on a lathe with gears like this is a sheer impossibility. In the United States such tools are not to be found on the market. Even the cheapest tools built in America have gears cut from the solid, and some pretence to accurate workmanship is made. The cost, however, of the cheap English or German tool is below that of the lowest priced American tool of equivalent size, and this accounts for the difficulty of introducing American iron-working machinery into Japan.

Every English lathe in Japan is a gap lathe, and there seems to be some difficulty in doing good work close up to the face plate, after the removable section of the bed has been taken out and put back a number of times, especially if much work has been done swinging in the gap, with the carriage over travelling the edge of the break. The fact that it is next to impossible to get a good job of machine work done in Japan is largely attributable to the inferior tools in use. For this reason also, the Japanese use soft castings, regardless of the fact that, though soft iron is easy to work, it wears rapidly when used for cylinders, valve faces, cross-head shoes and guides, and in like positions. Until this phase of machine-shop practice is radically changed American manufacturers need not fear Japanese competition in any country but Japan, and even there, home products are not considered when a really good article is wanted. Specifications containing the clause "None of the apparatus herein mentioned is to be of Japanese manufacture," are often drawn up by native engineers.

Good machinery, however, is to be found in some of the Government arsenals and the shops of one or two railway companies, and in these work is done that approaches western standards in accuracy and finish. These few good machines are making friends and paving the way for a radical change in the class of tools used in Japan. When that country emerges from the present financial difficulties which have hung over it for nearly two years, there will be many improvements in equipments and methods which have been retarded because of the lack of funds to make the changes.

Japanese engineers seldom specify a machine to be of given dimensions, of a certain type and efficiency, and to perform specified work. They usually hunt through catalogues until they find a picture and accompanying description which meets their ideas of what they need. They then write out a specification which is a verbatim copy of the description in the catalogue, frequently designating the number of the page upon which it is to be found. The maker is, of course, to be the party publishing the catalogue. Much trouble has arisen from this practice, as some of the handsomest and most complete catalogues are published by supply houses in America and England which build nothing whatever, and a machine with any name, other than that of the publisher of the catalogue, cast on it is liable to rejection. Certain European firms—and lest this be hurled back at me from the old world let me say here that my attention was first called to this by an English engineer in Japan—take contracts to supply machines from specified makers. They let the contracts to build these machines to jobbing shops by whom they are built for a trifling sum, and are worth about what they cost. The specified maker's name is cast upon the frames of the machines, and the purchaser, supposing them to be from these makers, accepts and pays for them. This has been a common occurrence in times past. The Japanese, however, are progressing so rapidly in their knowledge of these matters that this practice is becoming more and more difficult and less profitable, and will, no doubt, eventually die out altogether. The Japanese Government now requires with each bill of goods coming from a specified maker, a certificate from the said maker to the effect that he made and furnished the goods purporting to be from him.

Only a year ago a reputable company in England building woodworking machinery received a complaint from Japan concerning one of their machines. The machine in question was poorly made, would not perform its work properly and repairs were continually necessary. Upon investigation, the company whose name was cast in large, boldly-projecting letters upon the frame, discovered it to be an imitation of their standard machine, and during the months that it had been doing poor work this company which was not concerned in its production was getting an unenviable reputation for unsatisfactory work and questionable business methods.

The Japanese themselves have put out many imitations of pencils and small articles of a like nature with the names of English and American makers stamped on them, but so far as the writer knows,

they have never built any machinery with the names of foreign firms placed thereon or purporting to come from a foreign builder; though all the machines built in Japan are copied from similar ones built in Europe or America. The imported machines are dismantled, the various parts measured and patterns made therefrom. These imitations are all, however, confessedly Japanese, and are far from satisfactory in their appearance and operation. I have seen a simple condensing engine operating a paper mill in Osaka, with a condenser pump placed tandem with the cylinder and operated by a tail rod, on which the hand on the vacuum gauge oscillated between the five and eighteen inch indices with every stroke. The variation was due to leaks, and in certain periods of each stroke the hiss of air passing through the stuffing-box and past the piston could be plainly heard above the clatter of the engine, which pounded like a stamp mill. This engine was developing two hundred and fifty horsepower with coal worth the equivalent of $2.75 per ton and poor coal at that!

The Japanese have gone into the manufacture of high-speed engines and electrical apparatus. Their high-speed engines are not successful and probably will not be for a long time yet. Their electrical machinery seems to do better and give fairly good results in practical operation; but the efficiency is low and consequently the cost of operation high. Large and heavy generators have been attempted in only one instance. They work, but that is all. Their efficiency is not over 77 per cent. on full load, and even this figure is doubtful.

Within the past few years the questions of long-distance power transmission and distribution of power in factories by electricity have been taken up, and a few factory power-plants have been installed.

The first complete electric power distribution plant to be placed in Japan was contracted for by the Japan Car Building Co. of Nagoya. The plans were prepared by the writer and approved by Mr. I. Hattori, chief engineer of the company. The next plant of this character was also designed by the writer for Mr. K. Minami, president of the Hankaku Railway. It is operating the new shops of the Hankaku Railway Co. in a little town near Osaka. The Military Arsenal at Tokyo also has a few motors operating individual machines, though most of the machinery there is driven from line shafting.

ELECTRIC POWER FOR MARINE PROPULSION.

By Charles T. Child.

SINCE the earliest days of the mechanical propulsion of vessels, as distinguished from their propulsion by sails or hand-power, there has been a steady decrease in the weights of their machinery, an equally steady increase in capacity for power-storage, or, what is the same thing, coal-carrying capacity, and hence endurance, and a correspondingly great development of speeds. So far the steam engine is the only considerable factor in the situation, and marine engineering practice has so crystallised into definite rules regarding the power equipment of vessels that. given the tonnage, speed and endurance desired, and the class of service for which it is intended, the motive machinery of a floating craft of whatever sort is almost definitely specified.

The rapidity with which electrical power applications have been developed is amazing. In view of their present proportions it seems almost impossible that electric power was a curiosity of the laboratory twenty years ago. But the very suddenness of this development has made it incomplete. Progressing along two main lines,—application of electric power to stationary machinery and to railways,—certain minor possibilities have been neglected. It is to one of these, in connection with the propulsion of vessels, that it is desired to invite attention in this paper.

It may be stated at the outset that electrical motive power is, to-day, only available for certain extremely limited classes of vessels. The floating structure must, of necessity, be self-contained and not, like the familiar electric tram-car, only the translating part of a system comprising a stationary source of power and a conducting structure. It must carry its immediate source of power within itself, except, possibly, in the single case of canal-boats traversing a fixed route under exceptional conditions of operation.

The electrical equipment needed, therefore, for a vessel which does not traverse a fixed path so that it may receive its electrical energy from a generating station, necessarily comprises either storage batteries in some form, or primary batteries, these being the only available sources of electricity not directly dependent upon applied mechanical energy. It is almost useless to review the disadvantages

of the primary battery, even in its most refined and highly developed form. Its great weight in comparison to its available energy, bulk, generally unsatisfactory operation, and absolutely prohibitive cost, exclude it from consideration. It is, then, to the accumulator that the designer of electric vessels must turn for motive power.

The development of the accumulator has been gradual but steady, and, though far from ideal, the present types are fairly reliable and satisfactory structures. Most unfortunately, no certain success has attended any really radical departure from the types of accumulators first employed, the improvements being generally mechanical, whilst the fundamental principle of operation remains the same. No satisfactory substitute for lead and its salts has yet been found, and, these substances being specifically heavy, the weights of accumulators, proportionately to their energy out-put, are still very high. The largest improvement that has been introduced in their construction is through a more complete subdivision of the active materials employed and the general strengthening of the plates, permitting a higher discharge-rate than was formerly possible.

In the essentials of its operation an accumulator is simply a means for storing up potential energy. Electric current acting upon it produces chemical changes in the plates of which it is composed, bringing them to a difference of condition which constitutes them into an electric battery. For a reasonable length of time this condition of unstable equilibrium is maintained, but, upon the closing of an electrical circuit to which the plates are connected, they return to their original condition, giving back as electrical energy a certain proportion of that used in "charging" them, or, rather, in working chemical changes in them.

This return of electrical energy is, necessarily, not so great in amount as that expended in charging the cells. Furthermore, its amount is variable and dependent, among other things, upon the rate at which both the charging and discharging actions take place. This point is one of vast importance in connection with the use of accumulators for the driving of vessels. To illustrate, if a given cell is discharged from full charge at such a rate that the operation lasts ten hours, a certain definite rate of current flow is observed. Now if this rate of flow be doubled, that is, if the cell be called upon to work twice as fast as before, its charge will not last five hours, as might be expected, but only about three, the total energy return being about 60 per cent. of that obtained when the cell is working

at the slower rate of ten hours. Similarly, for a full discharge in one hour the energy is poured out at a rate about four times as great as that accompanying ten hour discharge,—but for only one tenth as long a time. These figures vary widely between various types of cells, those given being probably the fair average for cells built for stationary situations and a fairly definite *régime* of slow charge and discharge. Cells specially constructed for heavy discharge rates shew a better return, but are not so long-lived.

In addition to this troublesome difficulty of the wasteful effect of high discharge-rates, there is an even more serious trouble in the fact that high rates of discharge greatly damage the plates, causing them to bend, or "buckle," and forcing the active materials (oxides of lead in some form), adhering to the lead plates out of contact with the metal, thus destroying the cells.

Comparing the weights of an equipment of electric motors and accumulators and one of boilers and engines, it will be seen that the advantage of weight lies on the side of the battery. Electric motors, allowing the speeds to be high, can be constructed in fairly large sizes at weights of about 16 pounds to the horse-power of utmost maximum out-put. For the storage battery the weight would depend entirely upon the *régime* of discharge at which it is to be operated. With the best types of light accumulators now constructed for automobile vehicles, the weight has been reduced to from 64 to 75 pounds per horse-power-hour capacity at a five hour rate of discharge. To shew more clearly the interrelation between weight, capacity, output, and discharge the table below, giving data of the batteries of an automobile mail-wagon recently used in London are of interest.

Hours of Discharge	H. P. hours capacity	Discharge rate in h. p.	Lbs. per h. p.	Lbs. per h. p. hour
20	33	1.65	883	44
10	24	2.4	606	61
6	19.2	3.2	455	76
3	14	4.7	309	103
1	8.5	8.5	171	171

Total weight of battery, 1,456 lbs.; total bulk, 10 cubic feet.

A somewhat better type of cells, also used in electric automobile vehicles, shews 64 pounds per horse-power-hour, and 321 lbs. per horse-power out-put at a 5-hour rate.

Now, assuming the electric motors, circuits, controllers, etc., to weigh 20 pounds per horse-power capacity, the following table of weights, powers, and endurances may at once be constructed, using

the figures given above (for a type of accumulators by no means the best), and assuming an average loss of 20 per cent. in the conversion to mechanical power:

Endurance, in hours	20	10	6	3	1
Weight per h. p.	1124	777	586	406	234
Weight per hp-hour	75	58	105	158	234

Steam power plants, adapted for service afloat, weigh from 40 to 70 pounds per horse-power, complete with all auxiliaries except reserve coal, according to their size and design. Coal weighs about 2.5 lbs. per horse-power-hour delivered at the shaft. Hence, taking the average of 55 lbs. per horse-power as a basis, a comparison may be made at once between the steam and electric equipments, the data for the steam corresponding to those given above for electricity being:

Endurance, hours	20	10	6	4	1
Weight per h. p.	105	80	70	62.5	57.5
Weigh, per hp-hour	5	8	12	20.8	57.5

It might apparently be argued from the foregoing that the electric boat has no *raison d'être* whatever; but that this is not the case is not difficult to shew by a consideration of certain other elements in the design of a propulsive equipment. In the first place, the figures given, both as regards weights and coal-consumption, for the steam machinery, are not applicable to small boats. In units of small size the weights of engines, boilers, condensers, pumps, etc., are far above 70 lbs. per horse-power, while the coal consumption is greater than that mentioned above,—especially if the engines are frequently stopped and started, or worked below their maximum out-put. These conditions do not in the least interfere with the operation of the accumulator. It has no steam to blow off when the motors are idle, no loss, but rather a gain, in efficiency when it is worked at less than its normal out-put, and, once charged, it is instantly ready for service, requiring neither time nor expense to make it available for full power.

Another feature of the accumulator is that its efficiency is high when it acts to steady a variable load, working near the point of maximum charge as in accumulator installations in electric central stations ashore. Its life is longer under these conditions, and it furnishes a reserve power to tide over any disaster.

If, consequently, there is some craft, now operated by steam, which is worked under variable conditions of use, making many stops, and going often at half speed, it might be well to investigate the opportunities it affords for electric propulsion. An ordinary steam ferry boat, especially one making frequent trips over a short course, as, for ex-

ample, those running between New York and Jersey City, fulfills exactly the specification above. Take the case of such a boat, using compound engines of about 1,500 i. h. p. and making trips averaging 7½ minutes each with stops of equal length between. At full speed engines, boilers, and fires are being worked under economical conditions. About one-fourth of the time such boats, on a crowded river, are at half speed,—a highly inefficient state of things for the motive machinery. Half the total time they are stopped, the fires still burning and everything ready for the next passage.

If a line of these boats should be equipped with electrical propelling machinery and charged from a station ashore as they lay in their slips at the end of each trip, the result would be, if there were boats enough to keep one always in the slip, that the charging station would work on a steady load and could attain the very highest economy of operation. The over-all efficiency of batteries and motors would certainly approach, under the conditions of operation outlined above, eighty per cent., so that power might be actually applied to the shafts of the boats at a coal cost of not more than 2.5 lbs. per h.p.-hour. Adding to this freedom from vibration, prolonging the life of the boat, manœuvring ability of the greatest perfection,—for the pilot could operate the motors himself and thus perfectly coördinate the movements of the boat,—and the entire disposition of the machinery below the main-deck, one reaches a combination of good qualities certainly worth further investigation.

Briefly, the equipment of such a boat would require about 90 tons of battery and 10 tons of motors to replace about 70 to 80 tons of engines, boilers, auxiliaries, and coal. It would cost in the neighborhood of from $50,000 to $60,000 as against about $37,500 for the steam equipment. It would save at least four tons of coal per day, which, at the usual prices, would pay a large interest return on the additional investment in the boat and its share of the charging station.

But the ferry-boat is only one of many opportunities for electrical propulsion. Take the case of a boat requiring high speed, combined with silence and secrecy of movement, and, above all, instant control, —such a craft as a torpedo boat. Here the conditions are entirely different from those obtaining in the ferry boat. Economy is a secondary consideration. Indeed, all other elements of operation must be sacrificed to military efficiency,—in other words, to the fitting of the boat for its service as a sort of directed projectile. These vessels take desperate chances. Once discovered in an attack they are practically certain of destruction. Hence secrecy of movement, silence,

invisibility, and the absence of any elements of construction or operation likely to proclaim the presence of the boat, are all qualities of high value in this class of vessel. All these and more the electric boat possesses. Compare, for example, a steam driven torpedo boat with one of the same tonnage and speed operated by electricity. The electric boat is less visible, because it has no smoke pipes, no smoke issues from it, and, all its machinery being below water-line, its freeboard may be made as small as safe navigation allows. It is less vulnerable than the steamboat, because its motive equipment is water-shielded and also by no means so delicate as that of the present type of torpedo boat. On account of the small size of the individual pieces of its machinery it can be minutely subdivided into compartments, thus lessening the danger of sinking from a well-directed shot. Having no funnels to flame under the forced draught employed at high speed, it cannot betray itself in an attack, and its machinery makes far less noise than the flying engines and humming fans of the steam-propelled boat. With all these advantages it has one other, even greater, which is its perfect docility of control. The officer in charge can be steersman and engineer at once, for the control of both directing and propelling machinery may be brought under his hands in small space. And last, and in some ways greatest, is the fact that such a boat would require a smaller crew than the present type, thus reducing the risk of life in an attack with it.

But, unfortunately, the electric torpedo boat has one very serious disadvantage,—small radius of action. Such a boat can be built today, using accumulators of the best present type, and about the size of the smallest sea-going steam torpedo boats, capable of a rush speed of 22 knots or over, with an endurance of only one hour at this speed, while the same battery would give a speed of about 12 knots for 24 hours, or a slow-speed cruising radius of 288 nautical miles.

The electric launch has become as familiar as the automobile. In all varieties of small pleasure craft the cleanliness, compactness, ease of operation, and silence of the electric equipment have earned it a highly respected place. In the few submarine boats that have descended (and come up again) electricity has been successfully used as a motive power. On streams like the Rhine, where one end of the ordinary passenger steamboat course is marked by water-power, furnishing locally a low-priced source of energy, the advantages of electric propulsion might be worth investigation.

EDITORIAL COMMENT

WHILE a review of the various articles in the technical press does not always show startling changes from month to month, it is sometimes a very instructive record of the trend and growth of engineering thought and activity. For this purpose a glance over the columns of the Engineering Index is most serviceable, and although it may be open to the objection made by the individual who attempted to read the dictionary, i. e., that the stories are too short to be very interesting, yet after all the discovery of a single item upon one's chosen subject will frequently repay the brief labor of scanning the concentrated expression of the reading and analysis of the technical literature of the month.

It has already been observed in these columns that the work of the various departments of engineering is gradually outgrowing the distinct limitation it formerly set upon it. This is especially true of the work of the mechanical engineer, and it must naturally be so when it is considered how general the application of mechanical devices to all kinds of work is becoming. The great undertakings of the civil engineer are now performed, not by the aid of men with spades, or animals with carts, but by the infinitely more efficient and expeditious excavators, cableways, dredges, and the like. The architect finds himself more and more obliged to limit his work to the æsthetic side of his practice, broadly designing and planning the proportions and decorative features, but of necessity turning to the mechanical engineer to design and construct the framework, plan the equipment, and supervise the erection of the great structures which form so large a proportion of his work.

The same is true of mining and metallurgy, and of electricity, and it is evident that this broadening scope is destined to obliterate to a great extent the artificial boundaries which formerly were supposed to exist, and to merge all branches of engineering into one great profession, having, it is true, specialists in every line but forming a whole unit when considered broadly.

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There is a general and active interest in the study of the materials of construction, both in mechanical and civil engineering work, and the rapid development of the new science of metallography is already yielding valuable results. With the advanced knowledge of the physical constitution of materials progress is also being made in the methods of computation, and empirical rules and formulas are being superseded by rational expressions, based upon the real actions which take place upon the application of stresses and the production of strains. The extending use of concrete and cement in connection with metallic reinforcement is causing further study of the nature and strength of concrete upon the same lines as have already been applied to metals, and it is beginning to be realized that such materials as stone and concrete obey the same laws of elasticity as do the metals, and that data concerning the elastic limits are as important in the one case as in the other.

Among the papers devoted to electricity are found some of much interest. Attention is being turned to the possibility of producing an electrical accumulator which may be free from the objectional bulk and weight inherent in the lead-plate type. It appears as if the classical laboratory apparatus devised by Professor Grove, many years ago, may develop into a commercial and practical apparatus, and the gas storage battery may yet replace the lead plate. By using other gases than the constituents of water, and by working the apparatus under high pressure, it appears possible to obtain results which may become of much value.

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The interest in space telegraphy continues unabated, and since the successful transmission of messages across the channel, the Marconi system has become the feature of the day. The excellent results obtained by

Professor Ducretet in France, and the possibility of limiting the direction of the transmission to any desired quarter all point to the fact that what has been hitherto only a laboratory experiment, is in the immediate future to become a commercial enterprise.

Another feature of several articles of the month is the increasing attention which is being given to the use of polyphase currents in power transmission. Apart from the advantages and economy which result in the actual transmission, the satisfaction given by polyphase motors renders them applicable for many purposes. Especially is this true for mining purposes, and the possession of a motor without the objectionable commutator, free from all danger of igniting mine gases by sparking removes the one great objection formerly existing against the electrical transmission of power in collieries.

* * *

Electric traction, which has attained such dimensions in the United States, has also progressed rapidly on the continent, and the interest which is now being shown in the subject in England demonstrates that she too will soon possess her share of electric tramways. The obstructions of adverse legislation must rapidly give way before the pressure of public opinion, and the demand for convenient, cheap, and rapid local transport will be fully and completely met.

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The publication of certain untenable claims for liquid air as a source of motive power, briefly noted here last month, has been the occasion of a flood of papers upon the subject in journals of every kind and degree, and it is an excellent sign of the wide distribution of sound knowledge of fundamental principles, that any statement radically opposed to the ultimate laws of matter and energy is so promptly seized and met by readers at large. Liquefied air will undoubtedly have its uses, as was clearly pointed out by Professor Thomson in THE ENGINEERING MAGAZINE last month, but it will be for purposes of storage, of refrigeration, of reduction in electrical resistance, and the like that it will be found useful and not as an original source of power.

Compressed air, on the contrary, is meeting with a continually widening field of applications, and while it may not possess the theoretical efficiency in transmission which can be shown for some other forms it possesses many practical advantages which will render it most useful.

* * *

In the strict domain of mechanical engineering many papers of value appear. In all branches of work increased demands upon materials and mediums of mechanical effect are being made. Higher pressures for steam, air and gas, are the rule, and, in consequence heavier stresses upon the containing vessels follow. Boiler pressures reach 260 pounds, where a few years ago 100 pounds was thought high, while high temperatures and high speeds are too common to attract attention. The strength, or rather weakness, of certain forms of construction, such as pipes, fittings, joints, and the like, has been severely tested under such conditions, and in many cases the real action of combined pressure and temperature has not been fully appreciated until emphasised by disaster. Two notable papers of the month, one in Germany, and one in America, call attention to the necessity of revising the proportions of flange joints to meet the increased stresses, and the paper of Professor Bach, especially shows the extent to which fittings and connections often yield beyond the elastic limit where they have been assumed to be of ample strength.

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The development of the gas engine has been a frequent subject of comment in these columns, and the awakening commercial interest which has developed in the same direction is evidence that the advantages and economy of the internal combustion engine are being appreciated. Improvements in construction, regulation, and above all in the use of cheap forms of gaseous fuel, all these are uniting to emphasise the fact that in very many instances it is far better to burn the fuel in the cylinder where the work is done than under a boiler to generate steam. The most direct method is not always the best, but this is a case where in every point directness has been accompanied with gain. The internal combustion motor may not altogether supersede the steam engine in the near future for all purposes, but there is every evidence that before long the small steam engine will have to go, and its place will be

filled either by the gas engine or by the electric motor, or more probably by both.

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In railway engineering there is evidence of increasing attention to the advantages of the compound locomotive. The economy of compounding now appears to be generally admitted, and in many cases where fuel economy is not a matter of supreme importance steam economy is greatly to be desired. Increased steam economy practically means increased boiler capacity, and for the high-speed express train anything which increases steaming power is gladly welcomed. In like manner the heavy freight train on long stretches of level road makes a steady pull upon the boiler which requires all the steaming capacity to meet. It is in such cases that an economy of 15 to 20 per cent. is gladly welcomed, and it is in such service that the compound locomotive, both of the two-cylinder and four-cylinder type are making steady progress.

All through the broad field of engineering the Engineering Index thus makes record of the progress of the month and to follow its notes in the light of what has already been accomplished is to be prepared for what is to come in the many lines along which progress must be expected.

* * *

Britain has so long been the great workshop of the world that the spectacle of some of her own work being placed elsewhere is a startling one. The purchase of American engines has called forth much comment, some of it unduly pessimistic and some needlessly acrimonious. It is unnecessary either to assume that England is hopelessly worsted in the industrial struggle or to cry out that her rivals' goods are "cheap and nasty."

As a matter of fact, it seems that the placing of many of the orders going to foreign firms has been determined by early delivery quite as much as by anything else, and that English makers could not give nearly so prompt a delivery as others, simply because their works were already nearly overwhelmed with business. It would seem that there is small argument for the pessimist in this. But there is, undoubtedly, much reason to study critically the manufacturing system and industrial practice which has allowed the possibilities of productions to fall below the exigencies of demand. Without being upon the verge of extinction by foreign competitors, the British manufacturer may be failing to realize his opportunities or to avail himself to the full of the capacity of his works.

The facts are to be faced, and while the truth may be unwelcome, blindness to it is worse. Good work is evidently being done in America and Germany, and the rivalry which now takes the surplus of orders may take more, unless English makers avail themselves of every advance of practice, wherever it may originate. The keynote of American production is specialisation and standardisation—both not only compatible with good work, but actually conducive to the best. Their application in engineering works, in the United States and in Germany, is exhibited in detail in Mr. Orcutt's papers now current in THE ENGINEERING MAGAZINE—papers which a discriminating contemporary describes as "searching and salutary, even to a disapproving reader," though it attributes them mistakenly to another excellent engineering journal.

That which is "salutary" will not meet with disapproval from the far-sighted engineer. "My country, right or wrong," in the emergency—but "my country *right*" so long as there is opportunity—and may it be long before the end of the present season of opportunity for study, adjustment and advance.

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The struggle of the engineers for recognition in the Royal Navy seems to provoke quite as much bitterness as was exhibited in the similar movement in the United States, where an apparent solution has been found in the "Personnel Bill." It remains then to test in practice the measure which, while something of a compromise, expresses in the main the judgment of broad-minded men seeking the best results to the service.

The traditions of the sea are stubborn and slow-yielding, or the present order would long since have yielded to the inevitable progress of evolution. Time was when the military man was supreme, afloat or ashore, and the seaman was as subordinate as the deck officers (some of them, at

least) would now have the engineer. But with the progress of tactics and the growth of the advantage to be derived from skillful manœuvring, the sailor, who was the soul of the ship, inevitably forged to the fore, not supplanting but absorbing the purely military command.

And now another step has been effected. The "weather gauge" has given place to speed under steam, together with the speed in mobilisation, whose factors were ably summed up by Mr. W. Laird Clowes in THE ENGINEERING MAGAZINE for July, 1898, altogether an engineering proposition. From the first conception of her plans to the minutest move of her working in action, the warship depends upon the brain and hand of the engineer. It is inevitable that his position and authority shall be made commensurate with his importance. Whether the solution be found by merging the deck and engine-room officers in one body (as in the United States navy) or by a collateral development of two corps upon equal planes, found it must be, and speedily, as a necessary condition to the realization of the full effectiveness of that sea-power which is pre-eminently important to industrial stability and supremacy.

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About a year ago, the Secretary of the British Fire Prevention Committee applied to THE ENGINEERING MAGAZINE for permission to reprint the illustrated article by Chief Bonner, of the New York Fire Department, describing the equipment and organisation of that force.

This paper, which appeared in our issue for February, 1898, was the fruit of especial and unusual effort and expense; but, out of regard for the distinguished membership and useful aims of the Committee, the desired permission was given and the blocks were turned over to the Committee at a fraction of their original cost, the only condition affixed being that full credit should be given to THE ENGINEERING MAGAZINE for the original publication. When the pamphlet appeared, however, the stipulated credit was so effectively concealed in an introduction which few readers, probably, would notice that the editors felt the single prescribed condition had not been satisfied, though they could not believe it had been evaded.

When, therefore, application was again made to the Magazine, in February last, for permission to reprint Mr. H. DeB. Parsons' study of "The Tall Building Under Test of Fire," appearing, with its unique illustrations, in our issue for that month, expression of our former dissatisfaction was made and the new consent granted upon the express stipulation that acknowledgement to the Magazine be made upon the cover, and at the head of the article, by "a plainly printed line 'reprinted from THE ENGINEERING MAGAZINE,'" and the amends for the former neglect be made in the introduction.

On April 21st, after our May issue was off the presses, there came to the editorial desk a copy of the Committee's reprint of Mr. Parsons' article, in the usual red cover of the "Publications of the British Fire Prevention Committee."

The cover bears no word of acknowledgement to THE ENGINEERING MAGAZINE; an expression of indebtedness, with no reference, however, to the former neglect, is again lost in the introductory note, and the first page bears, in small italic type, the ambigious line "A Paper Prepared for the Engineering Magazine."

The paper was not only prepared for, and at the original instance of, THE ENGINEERING MAGAZINE, but it was fully published therein and the value of the study, for everyone interested in English fire-risks, was pointed out in our editorial columns in January last. The credit for its "timeliness," made much of in the preface to the reprint, is therefore ill-assumed by the Committee; the seeming effort to obscure THE ENGINEERING MAGAZINE's original presentation of the matter is, to say the least, ill-judged and ungraceful.

REVIEW OF THE BRITISH PRESS

Municipal Advantages of Motor Vehicles.

AMONG the various advantages which are likely to follow the general adoption of automobile vehicles, not the least are those which will affect the sanitary condition of great cities. This phase of the subject has already been briefly noted in a previous issue, and some definite data in the same line appear in a paper presented by Mr. E. Shrapnell Smith in the *Journal of the Sanitary Institute.*

There is no doubt that by far the greater portion of the filth which accumulates in city streets is due to the presence of the horse, and the removal of this source of annoyance and disease would alone render the general use of the automobile a great benefit, so far as sanitary considerations are concerned. Not only is the horse a producer of filth but he is also a distributer, since the pounding of hoofs upon even the hardest of highways assists the breezes in distributing the dust to irritate pedestrians, and poison exposed food-stuffs. To-day, owing to the droppings of the horse and the deteriorating influence of its hoofs, an enormous amount of labour and expense is necessary for street-cleaning purposes. Prevention is better than cure, for which reason the sanitary betterment of city streets by the introduction and extended use of motor vehicles should be encouraged.

Apart from the direct improvement in public health which the removal of the horse from crowded city streets would secure, there are important general economies which would be attained. Mr. Smith gives some interesting computations showing the actual operative economy effected by the use of motor dust-carts in the place of horse-drawn carts, and shows a saving per annum of 43 per cent. in London, and 26 per cent. in provincial cities, by the use of motor vans.

Another important advantage, and one which is as yet not fully appreciated, is the economy in road maintenance which would be secured by the use of motor vehicles. Undoubtedly by far the greater portion of the wear and tear upon pavements comes from the pounding of hoofs, and the effect of rolling contact, especially when the dragging action of hauling is absent, is rather beneficial than otherwise, tending to consolidate and improve the road, rather than to injure it. The universal adoption of wide rubber tyres which must necessarily follow the introduction of automobiles would render injury to the roadbed from vehicles practically impossible, and incidentally do away with most of the noise and distraction accompanying the present vehicles.

The relief which would be given to the greatly congested streets of most large cities is another feature which renders the use of motor vehicles very desirable. Nearly one-half of the space occupied by a horse drawn vehicle upon the streets is required for the animal itself and when the necessary room for safety to passers is included, it is not too much to claim that the available room in congested streets would be doubled by the use of motor vehicles. Apart from the mere room gained, the better control of the automobile is an important feature to be considered, the ease of backing alone rendering manoeuvering in close quarters far simpler than when horses are employed.

Taking all these manifold advantages into account, it will be seen that the motor vehicle has claims to consideration far more important than the mere pleasure or satisfaction of control which at first drew attention to it, and that on the score of health, of economy, of safety, and of increased capacity the use of automobiles of every sort should be encouraged and advocated.

Acting upon the paper of Mr. Smith, the Sanitary Institute expressed the opinion that the introduction and use of efficient motor vehicles would contribute to the general improvement of the sanitary condition of streets and towns, and recommended that this opinion be made known as widely as possible.

Water-Tube Boilers in the Navy.

NOTWITHSTANDING the many discussions which have been had concerning the defects of certain water-tube boilers which have been used in recent large cruisers there seems to be no disposition to return to tubular boilers, and in the description which is given in *The Engineer* of the machinery of one of the latest vessels, the first-class cruiser Spartiate, it is seen that Belleville boilers are adhered to as the form of steam generator.

This whole subject of water-tube boilers for large units is one which will bear careful examination, not from the controversial point of view, but rather with the aim of evolving the very best type practicable for the trying service demanded in vessels of the navy. Water-tube boilers have firmly established themselves for stationary purposes everywhere, and hardly a great power-house is seen in which there are not thousands of horse-power of water-tube boilers giving continuous and satisfactory results, so that there can be no question as to the real merit of this type of steam generator. The problem, therefore, is not that of designing a satisfactory water-tube boiler in itself, but of adapting the principle to the requirements of naval service.

So far as small boilers are concerned, the task has already been well accomplished, and there are several designs of boilers with small tubes and large steaming capacity which have demonstrated their value in torpedo boats, launches, and other situations. When it comes to the construction of large boilers, boilers which shall compare in endurance, reliability, and capacity with the tubular boilers which have rendered such good service in the past, then it is realised that the problem is not yet solved in a wholly satisfactory manner.

For large units and for boilers which are expected to render continuous efficient service, it is generally admitted that large tubes, that is, about four inches in diameter, are most desirable, the small tubes, such as are used in boilers for torpedo boats and destroyers, being hardly suitable for the larger boilers, in regard to capacity, surface, or ease of cleaning. Assuming then, the use of large tubes, the method of connection and of general disposition must be considered, and it is in these points that the leading boilers in use differ. In the case of the Belleville boiler, which has found extended application both in the French navy and in the merchant marine, the boiler is built up of so-called elements, each element consisting of a zig-zag combination of tubes and return-bends, extending from the lower feed collector up to the steam separating drum at the top. This disposition possesses the advantage of making the elements, and consequently the whole boiler, amply flexible to yield to expansion and contraction stresses, thus permitting rapid getting up of steam without risk of serious injury. At the same time the circulation is what is termed "restricted," and it must be apparent that, when driven to the full capacity, a boiler constructed on this principle must be liable to have the water from the lower tubes carried up with the ascending vesicles of steam. That serious cases of burning and bending of the lower tubes have occurred with this type of boiler proves that the restricted circulation has its disadvantages, and while in many instances the Belleville boiler has done remarkably well, yet there is no doubt that in the point of circulation at least its construction leaves room for improvement.

An unrestricted circulation is generally attempted to be secured by connecting the tubes both at the front and back, either with flat water spaces, or with sets of headers or manifolds, each tube thus delivering its steam into a direct uptake passage, and receiving a free supply of water from the other end. So far as circulation goes this works well, but it confines the tubes rigidly at both ends, and leaves little or no opportunity for expansion, the only relief being the lateral springing which may occur. It is claimed that the rapidity of the circulation maintains all parts at a nearly uniform temperature, but in practice it is a fact that bent lower tubes are not an uncommon occurrence with boilers of this type, and satisfactory results in practice are principally had by the use of short tubes.

Another form, aiming to obtain unrestricted circulation together with entire freedom for expansion, is constructed with tubes connected to headers only at the front end, the rear ends being closed with

caps, and the circulation being maintained by means of internal tubes or partitions. In some respects this type possesses many advantages, and excellent results have been secured with the Niclausse boiler, a good example of this construction. There is, however, an objection to having the tubes so arranged that they cannot be cleaned through from end to end without dismantling the boiler, a feature which should be attained wherever possible.

These three types, then, are the main forms of large-tube boiler now in use, and while none of them possesses all the features which go to make up a thoroughly satisfactory water-tube marine boiler, yet there is little doubt that out of the three types a final form will be evolved which will become the marine steam generator of the future.

Electricity in Mining Operations.

In considering the numerous applications of electric power transmission its adaptability to mining purposes at first seems most advantageous. That it is well adapted for operating underground machinery is undoubted, but there are many precautions which must be observed, especially in gaseous mines, otherwise difficulties are certain to be encountered.

A paper recently read before the South Staffordshire Institute of Iron and Steel Works Managers by Mr. J. H. Whittaker, and published in the *Colliery Guardian*, discusses many of the practical questions connected with the use of electrical machinery in collieries, with especial reference to the subject of three-phase currents and motors for power transmission, and touches upon numerous points of practical importance.

The earlier mining plants were constructed to be operated with the continuous current, and when properly installed and care exercised to provide a plant sufficiently large to meet the maximum demands of the work, satisfaction has generally been given.

The principal difficulties have been lack of strength to withstand the necessarily rough usage and proper provision against to presence of water. By using enclosed water-tight, motors, and the concentric system of wiring, the difficulties due to the presence of moisture may be overcome, while the matter of strength is one which can best be remedied by the reconstruction of defective apparatus after experience has pointed out the weak parts; electrical machinery not differing in this respect from any other kind of work.

It is with the motors that the greatest difficulties are necessarily experienced. The generator is usually placed in a clean dry room, with an attendant constantly on hand, and the brushes and commutator, are given every attention. The motors, on the contrary, have hard work to do, are subject to great strains, are generally placed in dirty and wet positions, and yet are generally given much less attention. Brushes are allowed to become worn and displaced, sparking follows, and unless prompt attention is given, the commutator is ruined.

Taking these points into account, Mr. Whittaker called attention to the advantages of the three-phase current for mining work, this being comparatively new for mining service in England, although numerous large plants have been installed on the continent, in America, and in South Africa. The chief characteristic of three-phase generators and motors lies in the fact that no brushes or commutators of any description are required, and thus a much higher degree of safety and durability is obtainable than with any other type of machines. By the use of the three-phase system practically all the objections to electric machinery for motive power in mining operations may be overcome. The absence of sparking is especially important in gaseous mines, since it has been fully demonstrated that under certain circumstances ignition and explosion may follow the production of sparks, and it has even been found necessary to enclose continuous current motors in cages of wire gauze to prevent the possibility of ignition of explosive mine-gases.

In addition to the element of safety, the three-phase current possesses marked advantages when there is any material distance between the generator and the motors, and by its use a distant source of power, such as is frequently found in mining regions, can be utilised and the current delivered to a number of mines with but

little loss. Where power has to be transmitted more than a mile, continuous currents are at a disadvantage, owing to the difficulties of maintaining the insulation of the armature windings and commutator at high voltages, and with low voltages the size and cost of the conductor becomes prohibitory.

The efficiency and ease of transmission of three-phase currents offer strong inducements to mining engineers to use them for transmission, and to use rotary transformers, giving out continuous currents at low voltage at the point of distribution for lighting purposes, and there is little doubt that the practice in Great Britain will soon follow that of other countries in this respect.

The Care of Marine Boilers.

DURING the late war between Spain and the United States some criticism was made of the American fleet before Santiago because of the injury which was done to the boilers of certain vessels because of the use of salt water in them, but from a discussion upon the well-worn subject of the steam consumption of marine auxiliaries in a recent issue of *Engineering*, it appears that the practice of supplying the deficiency of water from the sea is not confined to the American navy.

Referring to the failure of tubes in the Belleville boilers on the Terrible, *Engineering* says:

"It has never been claimed seriously that salt water can be used constantly, or for any great period of time, in the water-tube boiler of the Belleville type, or, indeed, of any other. The same remark applies to boilers of the cylindrical and all other types, and evaporators and distillers of ample capacity are provided on our vessels for making up the losses of feed water, which necessarily occur during regular work.

On steam trials the nitrate of silver test is applied to the feed water to determine if there is any leakage in the condenser, or any other possible sources of contamination with salt water and the engineer of the ship in command is expected every watch to use his hydrometer for the same purpose, so that the presence of sea water may be detected. There have been cases before now of the auxiliary feed having been opened up from the sea to make up a shortage—doubtless without the engineer's knowledge; and the wise precaution is now being taken to have no direct connection between feed pump and sea to the boilers, any sea water required being admitted in the engine-room. This precaution will certainly be effective.

"In one of the cruisers of the Arrogant type the bursting of three solid-drawn tubes was caused by deposit, probably due to the use of salt water, but these failures involved no damage because the furnace doors were not opened. It may be noted that a failure of this kind is not so much a question of welded against solid-drawn tubes, although the latter are to be preferred, as of avoidance of deposit in the tubes. In the Terrible the saline density of the feed was for some reason or other four or five times that of sea water. But even if a tube gives way, there is usually some warning by the partial leakage of steam, and the commendable course is then to shut the stop valve and open the safety valve of that particular boiler; but certainly not to open up the furnace. If such action be taken, experience has shown that there is no danger to life or limb. But, in addition, it must be remembered that disasters due to a similar cause have befallen the cylindrical boiler, and such mishaps would occur with practically any form of boiler, if sea water were used for any lengthy period. Moreover, there is in the case of the cylindrical boiler no such easy means of averting danger, as indicated in connection with water-tube boilers, as owing to the greater volume of water and steam contained in boilers of the former type, the opening of the safety valve has not the same immediate action as it has in the case of water-tube boilers."

All this is very interesting if we assume that the vessel during the experience of yielding tubes and loss of power is on some peaceful cruise, where speed is of no consequence, and a boiler more or less out of service does not much matter. When, however, as was the case of the American fleet before Santiago, a desperate enemy is making a bold dash for escape, and every pound of steam is needed, and even trial speeds must be beaten if possible, it is small consolation to know what may be done to pre-

vent disaster when the commander on the bridge is calling for more speed, and the full emergency capacity should be instantly available. It must not be forgotten that a warship is a fighting machine, and that her machinery of propulsion is as much a part of her fighting equipment as her batteries. It is as much a breach of discipline to permit her boilers to become scaled as to allow her guns to grow foul and rusty, and the presence of salt in the boilers is as reprehensible as that of water in the magazines. Boilers can only be kept clean by allowing nothing but pure water to enter them, and the detection of any form of scale in a marine boiler at any time is evidence of neglect of duty second only to treason.

Machine Tools.

THERE is no subject so important to the mechanic as the tools with which he does his work, and although it is an old saying that the good workman never complains of his tools, yet this is doubtless true because the good workman will not have tools of which complaint can be made. A general discussion of the present status of the machine tool problem is a feature of recent technical publications, and the latest contribution to the subject is a paper by Mr. E. C. Amos before the Society of Engineers, published in *The Mechanical World*.

That there has been a radical change in the general idea of machine-tool construction is now generally admitted. Says Mr. Amos: "One of the most noticeable features of the modern workshop is the largely increased variety of machines used, in many cases merely a modification of the same tool, and yet sufficiently different to secure some distinctly beneficial result. For instance, an ordinary lathe was formerly used for turning, boring, screw-cutting, and with various attachments also for milling, wheel-cutting, chasing, grinding, cutting-off, bolt and stud work, etc. In place of this we now have lathes specially designed for all these different operations, and with results never imagined by our predecessors. For the one machine doing a great variety of work we have substituted many machines, each dealing with one type of article or process, and this applies to most classes of machines. Another distinctive feature is that parts are all made to template, so that any part can easily be replaced, the increasing use of automatic machines making this duplication considerably easier."

A fundamental difference between the modern and the old-time tool lies in the fact that in the older machines the accuracy of the work depended very largely upon the workman who tended the machine, and it was his skill which made fine and accurate products possible. In the case of the modern machine the general arrangements are such that when it is once in adjustment, with tools properly set and ground, the duties of the workman are reduced to those of a mere tender, the accuracy of the product depending upon the machine itself and not upon anything the mechanic can do.

The economical use of such automatic machines depends very largely upon the number of duplicate parts which are to be made, and in this respect the general designer should work in fullest harmony with the manufacturer. Automatic machinery first came into successful use in connection with the manufacture of small arms, sewing machines, and more recently, of bicycles, but since the enormous advantage of repetition work has been fully demonstrated, there is every inducement for the designer of any product to unify sizes, and simplify details to the greatest extent possible, in order to permit as great a use of special and automatic tools as the case will permit. It is surprising to see how much can be done in this way, especially if the machine designer will collaborate with the manufacturer, and endeavor to adapt his ideas to the best facilities for their execution, and this branch of machine design is one which offers a wide field for advantageous study.

Speaking of the competition between American and British tools Mr. Amos says:

"Of the lighter classes of tools, hand tools, etc., the American make is undoubtedly superior to our own, and the competition in the larger machines is getting very keen. Then, again, where the American makers gain so much is in their method of manufacture. Their practice is to put in hand at least a dozen machines at the same time, stocking what is not to order, whilst we manufacture, as a rule, to order only. Their system enables

them to use elaborate jigs and templates. which secures accuracy, economy, and rapidity in manufacture, but does not pay in the case of one machine. Having set a tool to mill, plane, or drill a certain piece of work, it is evidently economical to be able to machine, say, a dozen or fifty of the same kind before removing the jigs and resetting the machine for other work.

"These are points which make it possible for Americans to sell a machine at prices approximating to our own, and often of better quality, notwithstanding the fact that they are paying a higher wage rate and have freight and other expenses to add.

"In large works, and especially in limited companies, where stock is put down at a big figure, it is doubtless inconvenient to throw out a number of machines, but many works at the present time would do the same turnover at less expense if they replaced their present plant of old-fashioned tools by half the number of modern machines. Given work to do, a good tool soon pays for itself, and will last longer, besides turning out far superior work to a cheap one, since the defective tool produces defective work, and at the same time demoralises the operator. Too much stress cannot be laid upon the advantages of good, and the disadvantages of bad tools, and it is satisfactory to know that the demand for high-class tools is largely increasing."

The Structural Strength of Ships.

AMONG the papers read at the recent meeting of the Institution of Naval Architects one of the most important was by Mr. J. Bruhn, discussing the structural strength of ships.

Mr. Bruhn began by calling attention to the fact that all attempts to consider a ship as a built-up girder were defective because of the assumption that the structure is continuous. The hull of a ship does not fulfill that requirement, and hence the common theory cannot be strictly correct. Where the larger portions of the structure are continous the girder theory is practically correct, but in the neighbourhood of discontinuities it cannot give a true indication of the stresses set up in the material.

After discussing in a general way the girder treatment, Mr. Bruhn proceeded to show the influence of interruptions of continuity, such for example as is caused by the cutting of a gangway door. In such a case the lines of direction of pull and push stress existing upon a continuous structure would be modified, and very complex stresses would be set up in the plating near the door. The mathematical evaluation of these stresses is a very difficult matter, but Mr. Bruhn showed that their general character can be determined, and by constructing the stress lines he showed quite clearly their nature and direction. In a similar manner the weakening effect upon a ship due to the cutting of hatchways was considered, and it was shown that hatchways of even moderate dimensions cause a very marked reduction in strength.

In order to demonstrate the mathematical deductions given by an analysis of the subject Mr. Bruhn used sheets of rubber, possessing a wide limit of elasticity, and when stretched and cut in a manner similar to the deck or sheets under consideration, these showed very clearly the nature of the stresses and the effect upon the material. The sheets of rubber were stretched with a parallel pull on a deal board; they had fine lines drawn upon them ¼ inch apart, both parallel and perpendicular to the direction of the pull, forming a complete set of squares, which, when the material was strained, became parallelograms. The elongation of these figures represented the strain and was measured directly by a scale. The shearing strains, as represented by the alterations in the angles of the parallelograms, were measured by a special device magnifying the scale ten times, thereby increasing the accuracy.

In the course of the discussion of the paper it was brought out very clearly that modern requirements have had much to do with the weakening of vessels. Large hatchways are in many cases required in order to permit the stowage of bulky pieces, while the necessities of the installation of the machinery often interfere with the best disposition of structural members. The only way to remedy these weaknesses is to strengthen the structure in such places as will compensate for the weakening effect as far as possible, and to this end an analysis of the stresses, such as Mr. Bruhn has attempted, is most valuable.

Especial emphasis was laid upon the desirability of making hatch openings and other interruptions of continuity, with round corners, instead of the square corners so generally in vogue. The analysis showed the great increase in stress at the sharp angle of any such opening, and this weakening effect may be materially reduced by using round corners, which also lend themselves readily to reinforcement. The advantage of a critical analysis of the stresses is shown in the fact that when their true distribution is shown it is often seen to be possible to strengthen the structure best by the addition of material at altogether a different place than that where the failure occurs. The so-called practical method is to reinforce the point of rupture, while it often occurs that a much more rational distribution of material can be made than that which is indicated by the mere fact of local yielding.

English and American Locomotives.

THE recent placing of orders in America for locomotives for English railways almost bids fair to revive the one-time controversy as to the merits of the respective types of locomotive engines adopted in the two countries, although that question was very thoroughly thrashed out several years ago. The real fact is that each type of engine is the outgrowth of its environment and is naturally best fitted for the work it has to do.

In the United States there are many grades, curves of short radius, rough roads, and all the features which must accompany the railways of a new country; this with all due respect to the magnificent road beds of such standard roads as the Pennsylvania Railroad, the New York Central, and other well-known railways. The result is a locomotive with bogie truck, flexible wheelbase, equalising levers, in short, everything which can be conceived to make the engine adapt itself to irregularities in the track. The necessity for these features is well pointed out in a communication regarding engines for South American railways, in the *Engineer*. Says the writer:

"I have worked both English and American engines. In one way the English engine is far the best; it does not wear out so quickly as the American engine. But I have almost always had to make alterations, such as giving more play in the axle boxes. It requires more care than the American engine. But the worst thing about it is that it racks the road as compared with the American engine. The last wears out much sooner than the English locomotive, but costs less money, and it is really a matter of no importance whether an engine lasts five or ten years. Let posterity take care of itself."

Just how the American engines will behave on English roads remains to be seen. The fact that they are built of a type which has been evolved from different conditions may have some bearing upon the case. Still it is well-known that the locomotives built by the firms which are now engaged upon the English orders have given a good account of themselves on railways in the United States, which are of a high character, both as regards permanent way and administration renders it possible that excellent machines will be supplied; machines which should do well in any part of the world.

Engineering Methods in England and America.

IN several editorials in *The Engineer* there has been a rather trenchant discussion of the difference between English and American engineering methods, with especial reference to the reasons for the placing of certain important orders in the United States, notably for American locomotives and for the Atbara bridge.

There appears to be little doubt that the preparations of specifications, as at present conducted in England, by engineers entirely out of touch, so to speak, with the manufacturers, has much to do with the difficulty experienced by English manufacturers in competing with Americans who are given greater latitude. As *The Engineer* says:

"The specifications prepared by civil engineers, acting for the colonies, are so severe and so full of special conditions and stipulations, that English and Scotch builders will not touch them at all, if they can help it, and only work without incurring dead loss if the price is very high."

In the United States, on the contrary, the standard designs are those of the locomo-

tive builders themselves, and, subject to slight modifications only, the builder is not hampered by details which involve special patterns and peculiar proportions, but is only given general results, which he is expected to attain in his own way.

The same is true in connection with bridge design. The original design for the much-discussed Atbara bridge included a precise specification, which was rescinded when it was found that false works were inadmissible, and instead, only the main requirements, i. e., load, span, and conditions of erection were given, and under these the American builders were able to name so much shorter a time than any English firm that the order was of necessity placed in the United States. This followed because, as *The Engineer* says: "Bridge building has been to a large extent standardised in America, makers have not only all the parts in readiness for immediate use, but have at hand all necessary tools and templates for commencing work on any particular type at a moment's notice."

In England, on the contrary, it is largely the custom for every designer to get out proportions which differ from those of other people, and, moreover, to insist upon having them, so that no ironmaster will dare to roll large quantities of sections, which may or may not be required.

Of course this evil of heterogeneity has grown with expanding trade, and the blame cannot be laid heavily on the maker's shoulders. The contracting engineer and designer are quite as much and more to blame. Whilst they continue to specify sections which do not exist they not only cause delay by necessitating the turning of special rolls for that particular order, but they put the manufacturer in such a position that he is nervous about stocking such great quantities as the American can with safety put into store. That the price must be higher for both reasons, is obvious."

It is not only to locomotive building and bridge construction that these facts apply, but to many other branches of engineering work. Economy in construction combined with excellence of workmanship and promptness of execution comes only with the application of systematic reproduction of standard types. The day is rapidly passing when each engineering work can be a distinct and individual product, and the time is coming when standardisation must be considered as essential. So long as a reputable builder is prepared to guarantee results, it is for him and for his engineers to decide by what means those results shall be obtained. The true place for the skilled engineer is in the works in which his designs are to be executed, and instead of devising details and specifications for individual structures, his energies should be bent toward the evolution of standard types from which any desired combination may be made at short notice and of highest character. It has been said that science is "knowledge reduced to a system," and modern engineering is rapidly becoming to mean "practice reduced to a system," and the systematised practice is certain in the long run to supersede practice without system, however skillful it may be.

REVIEW OF THE CONTINENTAL PRESS

The Progress of Electro-Metallurgy.

THE increasing extent to which electricity is being applied in metallurgical operations is evident in many directions, and in a general review of the recent advances which have been made, M. P. Chalon, in the *Revue Industrielle des Mines*, gives some useful data.

The utilisation of electricity in metallurgical operations includes two distinct methods, although it is supposed that in some cases they are combined; namely electrolysis and electrothermancy. Electrothermic methods have been in use for a number of years in connection with the production of aluminum, sodium, potassium, etc., and more recently the intense heat of the electric furnace has been employed in making calcium carbide and carborundum, but apart from these applications there has been little progress of late in electrothermic methods.

Electrolytic methods, on the contrary have emerged more and more from the domain of the laboratory and are daily receiving new applications in practice, and while it is too much to say, as some have done, that they will altogether replace the older processes, yet there is no doubt that they are already rendering notable service. Along this line of work many important researches are being made.

The older processes of Becquerel (1835), Clinton (1840), Werdermann (1880), and Blas and Miest (1883-4), aimed at the ideal operation, that of the electrolytic winning of the metal direct from the ore, but the crude methods employed, and the necessity, in the case of the earlier experimenters, of employing current generated by batteries, made the cost prohibitive. With the advent of mechanically generated currents, however, electro-metallurgy took a fresh start, and to-day is an important branch of industry.

After examining the chemical and electrical laws which govern the practical applications of electrolytic methods, the author gives from the computations of M. Minet, the mechanical equivalents which are theoretically necessary for the electrolytic and electrothermic production of a kilogramme of various metals, and while the reader is referred to the original paper for the complete list, some of the figures may be of interest here. Thus gold, silver and platinum require 0.70 horse-power hours per kilogramme, while for copper, nickel, iron or zinc three to four horse-power hours are needed, these being for electrolytic methods. The reduction of a kilogramme of sodium by the electrothermic process requires twenty-five horse-power hours, and for a kilogramme of aluminum thirty-five horse-power hours are necessary.

The most extensive applications of electrolysis in metallurgy have been in connection with the refining of copper from the impure mattes produced by the smelting furnace, as will be seen by the fact that there are five electrolytic refineries in Germany, four in France, five in England, two in Russia and eleven in the United States. The eleven establishments in the United States produced, during the year 1896, 124,000 tons of electrolytic copper, 14,000,000 ounces of silver and 70,000 ounces of gold. As the process is now employed, the anode consists of the impure copper and the cathode of pure copper, the bath being an acid solution of sulphate of copper. Electrolysis is also employed for the separation of nickel from copper and from gold, silver and platinum. In this case the anodes are the mattes containing the various metals, and the cathodes are sheets of pure copper, the bath being dilute sulphuric acid. The copper goes to the cathodes, the nickel dissolves in the bath, while the gold, silver and platinum are deposited in the form of a mud. The nickel is subsequently separated electrolytically, using insoluble anodes of lead or carbon and cathodes of nickel.

Much attention has been given to the electrolytic production of zinc, since the ordinary methods are still very crude and

expensive. There are many difficulties, however, in connection with the practical commercial applications of electricity to this metal; its solutions are poor conductors, the metal is frequently deposited in a spongy state, and above all, the low market price of zinc renders an electrical process proportionally almost too expensive. The processes of Siemens and Halske and of Hoeffner have both met with some success, but the best results have thus far been obtained by use of the Ashcroft process, in which a solution obtained by treating oxide of zinc with ferric chloride is electrolysed. This process has been used on a large scale at Broken Hill, but it is not yet altogether demonstrated that the commercial economy of any of the processes is satisfactory unless the recovery of more valuable associated metals is included.

Electrolytic processes as applied to gold and silver only appear as secondary methods. In the case of silver, the Moebius process is employed to advantage in separating it when alloyed with gold, while in connection with the Siemens and Halske modification of the cyanide process the electric current has been very successfully used in the Transvaal as a substitute for, and improvement on the method of reducing the gold by means of zinc shavings.

At the present time the various processes of electro-metallurgy may fairly be considered to have passed the experimental stage, and while there are doubtless many improvements to be made, there is every possibility that the electrolytic tank will in very many instances replace altogether the more primitive furnace.

The Functions of the Steam Jacket.

THERE has for a long time been more or less controversy about the utility of steam jacketting as applied to the cylinders of steam engines, and eminent authorities are still divided as to the economy or otherwise effected by its use, each side apparently being able to quote examples of careful tests to sustain its views.

A very careful review of the whole subject of the functions of the steam jacket, by M. Lefer, is given in a recent issue of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, following the lines of the analysis of Hirn and Hallauer, and showing how many conditions affect the results and why such contradictory views are possible.

After discussing the heat exchanges as they are supposed to take place between the steam and the cylinder walls in the case of an unjacketted cylinder, M. Lefer goes on to consider the case of a cylinder of which the barrel only is jacketted, and one of which both barrel and heads are jacketted with live steam. The initial condensation and subsequent re-evaporation which go on in the unjacketted cylinder are modified by use of the jacket by the presence of a source of heat which adds its action to that of the cylinder walls. The rapid variations of temperature which occur during the admission and cut-off are practically the same in a jacketted as in an unjacketted cylinder, as the rapidity of the changes is such that they penetrate the metal of the walls only to a very slight depth.

The principal action of the jacket takes place during the exhaust. In an unjacketted cylinder there must always be moisture upon the walls at the beginning of the exhaust, and there will consequently be a re-evaporation, abstracting a certain amount of heat which cannot be restored until the beginning of the next stroke. In the case of a jacketted cylinder the action is not the same. During the exhaust period the interior of the cylinder is in communication with the condenser, of which it tends to assume the temperature. In the jacket, on the contrary, there is a supply of live steam, of a relatively higher temperature. There results an energetic transfer of heat from the outer wall of the cylinder, in contact with the jacket steam to the inner wall, and, if there is no moisture upon the inner wall to be evaporated, all the heat thus transferred will go to elevate the temperature of the inner walls. The essential difference, therefore between an unjacketted and a jacketted cylinder lies in the fact that in the latter case the walls are heated during the period in which there is time for the absorption of the heat, while in the former case the walls become cooled in proportion to the duration of the period of exhaust. Since the cylinder is heated

every stroke, it therefore follows that in the one case the heat must be abstracted from the live steam during the period of admission, while on the other it is supplied from the steam in the jacket. The only advantage, according to M. Lefer, in the use of a jacket, then, lies in the fact that it diminishes the initial condensation; this reduction in initial condensation, however, being made at the expense of heat furnished by the steam in the jacket.

The benefit realised by the use of the jacket, therefore, according to M. Lefer, may be summed up as follows:

1. The partial condensation of steam in the cylinder at the beginning of the stroke being to a large extent diminished by a condensation of steam contained in the jacket, the water produced in the latter is returned to the boiler, while in the former case it passes on into the condenser.

2. The water produced by any condensation during the period of admission being wholly re-evaporated during the period of expansion, and the work represented by this is exerted upon the piston.

3. The absence of moisture on the cylinder walls at the beginning of the exhaust period avoids the abstraction of heat from these walls, which would otherwise take place by the evaporation of the moisture.

For these reasons a steam jacket should be used if it is desired that the highest degree of economy is to be attained.

Since the re-evaporation occurs mainly during the period of expansion, and the whole question of initial condensation and re-evaporation depends upon the extreme differences of temperature in the cylinder and the period of time during which the heat exchanges can occur, it will be evident that in engines in which there is a late cut-off, and which exhaust against atmospheric pressure, there will be little or no advantage in the use of a jacket, and this explains why in many cases tests show that its use is unattended with economy. In the case of a multiple expansion engine the use of a jacket upon low-pressure cylinders is frequently a source of loss, since the range of temperature is not sufficiently great to cause a material benefit to be realised, while at the same time the greater radiating surface causes an increased external loss of heat.

M. Lefer gives a number of comparative indicator diagrams in illustrations of the points made by him, and his impartial examination of this much-discussed question is a valuable contribution to the science and practice of steam engineering.

A Study of the Gas Engine.

THE increasing interest which is being given to the industrial applications of gas engines and other internal combustion motors gives added value to the numerous recent scientific discussions and investigations of the subject. The advent of the Diesel motor has attracted attention to the advantages which may be obtained by using increased compression, and the possibilities of employing cheap forms of gaseous fuel have caused the makers of gas engines to study the proportions and arrangements of parts best adapted for the modified conditions.

Among the scientific studies of gas engines an important one is contained in three papers by Prof. E. Meyer, contained in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure*, and based upon experiments made with a Deutz Otto engine in the mechanical laboratory of the Technical High School at Hanover. In these tests the engine was so arranged that different degrees of compression could be employed, and the mixture of air and gas were varied and the motor operated at different speeds in order that comparative determinations of the influence of these elements might be obtained.

After discussing the calorific value of various fuels, and describing the methods of calorimetry used in testing the fuels employed, Professor Meyer goes on to examine the method of computing the heat balance of the gas engine, deducing the equations by which the distribution of heat may be computed, and showing the method of their application. Broadly speaking, the total heat may be divided into three portions, one of which appears as effective work, one as an increase in temperature of the water in the cylinder jacket, and the third goes out with the exhaust gases.

It is not always easy to determine the exact division of the heat losses, but by careful measurement of the volume and rise in temperature of the jacket water and

by brake measurement of the effective power exerted by the engine, the remainder may safely be assumed to represent that portion which is rejected with the exhaust gases. When, however, it is attempted to so modify the action that a greater portion of the rejected heat may be converted into work it is necessary to understand the principles which control the heat distribution if improvement is to be expected.

Thus, if an attempt is made to diminish the rapidity of circulation of the water in the jacket, or in similar manner to reduce the proportion of heat carried off through the cylinder walls, it will be found that in general, the only effect will be to increase the proportion rejected with the exhaust gases, the thermal efficiency remaining about the same. An examination of the diagram of the cycle of operations which takes place in the cylinder, however, in connection with the thermodynamic analysis, shows that an increased compression of the explosive mixture should result in an increased efficiency, and it was to demonstrate the truth of this point that many of the experiments were made.

The engine used in the experiments was one of the ordinary Otto type, with the exception that the piston rod was made in two parts, one portion sliding within the other. By use of a clamp and set of split bushings it was possible to alter the length of the rod without altering any other conditions, and thus the degree of compression could be varied and corresponding trials made.

A carefully calibrated Prony brake enabled the effective power developed upon the shaft to be measured, and both the gas and the air entering the cylinder were carefully metered. Thermometers reading to 1-10 of a degree C. were placed in the admission and discharge pipes for the jacket water, the volume of cooling water being determined in calibrated tanks. The indicator by which the diagrams were taken from the cylinder was provided with a water-cooled stop-cock, so that diagrams could be taken continuously without excessive heating of the instrument, and the temperature of the exhaust gases was measured by means of a specially constructed pyrometer of the Le Chatelier type.

The results of these very complete trials are fully tabulated in the paper of Professor Meyer, and to the original memoir the interested reader must be referred. The general advantage of compression, however, will be seen from the following condensed statement of the average results of trials with four different degrees of compression; all being made with a gas of a calorific power of about 4,700 calories.

The consumption of gas per indicated horse-power when the mixture was compressed to 24 per cent. of its original volume, was 533 litres; when compressed to 25.8 per cent., 559 litres; when compressed to 31 per cent., 624 litres, and when the compression was to only 37.5 per cent. of the original volume the gas consumption per horse-power was 738 litres. There was thus an increase in gas consumption of 38 per cent. in the last case as compared with the first.

Professor Meyer's paper is an important and valuable contribution to the rapidly growing literature of internal combustion motors, and it is to be hoped that his experiments will be the cause of further and similar researches elsewhere.

The Development of Metallography.

THE revelations which the science of metallography have made in the domain of the physical structure of metals used in construction have been deemed so important that the German government has provided for a special investigator in this branch of applied science at the Charlottenburg Testing Laboratory. Professor Martens announces that Herr E. Heyn, a former pupil of Professor Ledebur, has been engaged during the past year in a special line of investigations in metallography, or the microscopical study of etched metallic surfaces, the results of which are now given to the engineering world through the medium of the *Mittheilungen aus den Königlichen technischen Versuchsanstalten* in the form of a carefully written memoir, together with a large number of photogravure reproductions of microphotographs.

Researches in metallography are ordinarily made by subjecting the polished surface of the metal to the etching action of dilute acids or of iodine, and by studying

the structure thus revealed under the microscope, the metal being etched only to a very slight depth. Herr Heyn, however, has followed a line of investigation first suggested by Osmond, and by using the so-called method of "deep etching" has obtained results of much value and interest.

In studying the physical character of iron or steel by deep etching the polished surface is treated with ten per cent. nitric acid for a period of several minutes, the result being a development of molecular structure governed by the varying depth to which the surface is penetrated. When such a deeply etched surface is studied under the microscope, especially with the aid of oblique illumination, the presence of the various forms of carbon and carbon compounds can be seen very clearly, an apparently crystalline structure being formed by those portions which resist the action of the acid. The figures which are thus formed are, however, not generally true crystal forms, but at the same time their study leads to an understanding of the character of the material to a degree not otherwise possible. An excellent preliminary to the study of metals by this process is the examination of well-known crystalline materials of other kinds. Thus if a crystal of rock salt be taken and either a natural crystal surface, or an artificially polished section be partially dissolved, a microscopical examination will reveal a number of more or less plane surfaces, often symmetrically disposed and together forming the so-called etched patterns. As the composition of the material is already known in such experimental cases, the relation of the etched pattern to the real crystalline forms can be compared and studied. Much in this connection depends upon the relation of the etched surface to the true crystalline planes, and a few experiments in this direction with known materials will do much to clear up apparent discrepancies which are met in the course of original investigations.

It is impossible to discuss the remarkable results which have been attained by Herr Heyn without reference to the beautiful microphotographs of etched sections which accompany his original memoir, but a general review of the examples submitted with the paper is most convincing evidence of the important relation which physical structure bears to strength and durability in metals of construction. It is quite possible for a material to yield an apparently satisfactory chemical analysis and yet be structurally very defective, while the crystalline arrangement must have a most important influence upon the questions of wear and endurance.

The whole subject of the strength and value of materials of construction is so intimately bound up with questions of a physical and chemical nature, that metallography forms a common ground upon which chemists, physicists and engineers must meet and exert united efforts, and nowhere is such work being done to better advantage than in the Royal Testing Laboratory at Charlottenburg.

The Storage of Electrical Energy.

THE question of the storage of electricity has received a great impetus by the rapid development of electric driving in all directions, and notwithstanding its many objectionable qualities, the lead plate accumulator, as originated by Planté and improved by Faure and others, has found numerous applications. The great bulk and weight of even the best of existing storage batteries, however, has always been a drawback to their general use, and great as their advantages have proved for equalisation of load in power-house service, it is yet a question of uncertainty as to their permanent value in portable work.

Under these circumstances the revival of the possibilities of the so-called "gas battery" as a rival to the lead plate accumulator is a matter of decided interest both to electricians and mechanics. The original gas battery of Professor Grove was designed to demonstrate the reversibility of the decomposing electrolytic action of the current, as enunciated by Faraday in his famous "researches," and consisted of a series of tubes containing alternately oxygen and hydrogen. Each tube contained a plate of platinum, roughened with a deposit of black platinum powder, and when the tubes were inverted in jars of acidulated water and the alternate platinum plates connected as in a galvanic battery, the reunion of the gases produced a current which af-

forded all the ordinary electrical phenomena.

Grove's gas battery was but a lecture room experiment, but as such it made a most beautiful contribution to the theory of the correlation of forces and conservation of energy, but the feeble current produced seemed to render it improbable that the apparatus would ever prove of commercial utility. Recently, however, the subject has been revived, and from a recent paper in *La Revue Technique* the suggestions of M. de Nansouty are given, from which it appears that a modification of the original demonstration of Grove may enable some very practical results to be obtained. In the Grove battery only oxygen and hydrogen were used, these being in the proportions to form water, and being generally produced by the electrolytic decomposition of water, and the whole apparatus was operated at atmospheric pressure. M. de Nansouty first calls attention to the experiments of MM. Cailletet and Collardeau, in which it was demonstrated that by working the apparatus at high pressures the capacity was greatly increased. By using spongy platinum electrodes, and decomposing acidulated water in a steel vessel capable of resisting a pressure of 1,000 atmospheres, it was found that for every kilogramme weight of platinum, with the gases at a pressure of 580 atmospheres, a capacity of fifty-six ampere hours could be obtained, with a discharge current of 100 amperes per kilogramme. A number of experiments along this line resulted in the conclusion that the capacity increased with the degree of compression to which the decomposed gases were subjected.

The next step in the increase of the capacity of the gas accumulator was found in the employment of other gases than the constituents of water. Thus, for example, the decomposition of hydrogen into its constituent gases by the electric current and the retention of the gases in a closed vessel under high pressure enables electricity to be stored and again returned when the reunion of the constituents is permitted. It has been demonstrated that in the production of hydrochloric acid an electromotive force of 1.37 volts is produced, and by a suitable connection of gas battery cells of this or similar type almost any desired combination may be obtained.

It is also suggested that this return to the chemical production of electricity may develop another side of the industrial problem by the adaptation of suitable devices to recover, as a sort of by-product, the electrical energy which is now generated and lost in large chemical works, such as the Solvay process, and, by means of the gas accumulator, send out stored electricity for use in all the manifold lines to which it may be applied.

However practicable this last idea may be, there seems to be every indication that in the gas accumulator, working at high pressure, and using such decomposable liquids or liquefied gases as may be found most suitable, there may soon be found the ideal device for the storage of electrical energy, free in great measure from the drawbacks of excessive weight, rapid deterioration, and high cost, which at present appear unavoidable with the lead plate types of storage battery.

The Behaviour of Acetylene Mixtures.

WHEN acetylene was first introduced as as illuminating medium, it was supposed that its most effective field would be as an entire substitute for ordinary illuminating gas, but commercial considerations appear to have prevented its general use in that manner. Compressed or liquefied acetylene has not been used to any extent because of the evident danger which accompanies the gas in those forms, and thus the principal field which remains open, apart from isolated plants and experimental work, appears to be that of enriching other less costly gases. Such mixtures may be of two kinds, the gas with which the acetylene is mixed being either a combustible and illuminating gas itself and the acetylene being added only to increase the illuminating power, or the acetylene may be mixed with an inert gas, useless in itself as an illuminant, and used in this connection only as a means of diluting the more expensive material. The former method has met its widest application in Germany, where mixtures of acetylene and oil gas are extensively used for lighting railway carriages, and the experiments of Dr. Gerdes, which have been reviewed in

these columns, have showed very clearly the extent to which this may be safely and profitably done.

A recent issue of *Comptes Rendus* contains a contribution to the French Academy by MM. Berthelot and Vieille, to whom so much accurate information upon the properties of acetylene is due, discussing at length the question of the explosibility of mixtures of acetylene with inert gases, and an abstract of the views and results of these able experimenters will be of interest and value in connection with the utilisation of acetylene.

It is well-known that acetylene belongs to the class of endothermic compounds, and disengages heat in course of decomposition. It is therefore desirable that it should be mixed with an exothermic substance, since it is the rapid development of heat which renders the decomposition of acetylene so liable to be accompanied with violent explosion, and the presence of a heat absorbing gas can be used to neutralise this effect.

Since it is most desirable for portable lighting that the gaseous mixture should be compressed into suitable containing vessels, it is important that the explosibility under pressure be determined, and numerous experiments were made to that end. Tests were made both with hydrogen and with Paris illuminating gas, these being mixed with acetylene in the proportions of one-fourth, one-third, and one-half acetylene, the mixture being compressed into a suitable tank and ignited by an electrically-heated wire.

As in the case of pure acetylene, it was found that no definite critical pressure exists at which ignition causes explosion, there being rather a zone, more or less extended, of pressures within which the probability of the propagation of ignition varies with extreme rapidity. The determination of the limits of this zone, therefore, becomes a matter of much importance, if acetylene mixtures are to be used with safety. A number of other points were determined by the tests, the original pressures being compared with those attained during the explosions, and temperatures measured or computed as closely as possible.

A general summary of the results is all that can be given here, and the salient points are as follows:

In all cases the maximum pressure obtained in cases where explosions were produced, was much lower than indicated by computation, even under the highest initial pressure which was used, i. e., at 583 pounds per square inch and with the mixtures containing the greatest proportion of acetylene, while for poorer mixtures, at the lower pressures of 100 to 150 pounds per square inch, the pressure of explosion was proportionally lower. The pressure at which explosion occurs is naturally lower the richer the mixture is in acetylene. With equal volumes of acetylene and hydrogen a pressure of 57 pounds per square inch is sufficient to cause explosion to accompany ignition, while for one-third acetylene and two-thirds hydrogen, a pressure of 100 pounds is required, and with one-fourth acetylene to three-fourths hydrogen the pressure must be increased to about 150 pounds per square inch. For mixtures of acetylene with illuminating gas the dangerous pressures are higher, being about 100 pounds per square inch for equal volumes, about 170 pounds for one-third acetylene, and as high as 550 pounds for one-fourth acetylene to three-fourths illuminating gas. This effect is presumed to be due to the presence of formene in the illuminating gas, its absorbing capacity for heat counteracting the endothermic action of the acetylene. In using such mixtures it must be remembered that the explosibility increases very rapidly as the proportion of acetylene is increased, but within the limits above given there is reason to believe that no danger from explosion exists.

This exhaustive series of trials is but one more of the valuable contributions which MM. Berthelot and Vieille have made to the practical applications of acetylene, and it is to such careful and authoritative researches that applied science owes some of its greatest debts.

Experiments on Steam Connections.

THE increasing pressures which are met in modern steam plants have rendered necessary a review of the accepted proportions of pipe flanges, valve bodies, and similar connecting elements, and an important

study of the effects of pressure upon existing designs of these members has recently been made by Professor C. Bach, and published in the *Zeitschrift des Vereines deutscher Ingenieure.*

While this paper is largely a record of results, and can only be reviewed in the broadest manner, yet it is such an excellent example of the manner in which such subjects can be studied that it is worthy the attention of manufacturers especially who are engaged in the construction of these important members of a steam power plant.

Every mechanic knows that it is one thing to make a flange joint which shall be strong enough to resist breakage and quite another thing to insure that it shall be tight against leakage under all the trying conditions of continuous service. Much of the trouble in connection with leakage lies in the fact that flange connections, whether on pipes or on valve bodies or fittings, are not stiff enough to resist deformation when subjected to high pressures. Realizing this fact, Professor Bach has conducted a series of experiments in which contact points were so arranged that the deformation under pressure of the various important parts could be accurately measured, and thus he obtained data as to the weakness of existing designs, so far as deformation is concerned, which no rupture tests could furnish.

By comparing these deformation tests with the actual strength and elasticity of the material as indicated by trials in the testing machine, the nature and magnitude of the fibre stress in various portions of the tested pieces was obtained, and thus a check upon theoretical computations of resistance was secured.

The tests were made upon wrought iron pipes, and upon valve bodies of cast iron, cast steel, and bronze, and the data thus obtained are tabulated in a manner which renders them available for use in connection with future designs. The whole subject of steam connections should be revised in view of the changed conditions which modern practice has brought about, and makers of valves and fittings for such service might well conduct some such tests upon their own account in order to be assured of the correctness of the proportions adopted by them.

Ice Breaking Boats in Russia.

THE use of powerful boats for breaking the ice in frozen harbors and thus maintaining a channel open for navigation is well-known in the United States, but the only country in Europe in which such boats are used is Russia.

In a communication to the *Comptes Rendus* of the French Academy M. Venukoff gives some notes about Russian ice boats. In February of the current year a powerful boat of this class was put into service in the harbor of Cronstadt, where much trouble is experienced from the ice. This ice boat is equipped with engines of 12,000 horse-power, and is able to maintain a speed of about two miles an hour through ice five feet thick, or four and a half miles per hour when the ice is only three feet in thickness. There are four screws, of which one is intended to break the ice and the other three are to propel the boat through the broken ice and clear a channel. There is a still more powerful boat of the same type in the harbor of Rével, the engines in this case being of 23,000 horse-power.

In connection with the transportation of trains of the Trans-Siberian Railway across Lake Baikal, it has been found necessary to employ very powerful ice-boats, and there is one in this service with engines of 40,000 horse-power doing good service in connection with the train barges by which, until the connecting line around the lake is completed, the trains are transferred from the western to the eastern section of the railway. There are also some very powerful ice breakers in use at the ports of Odessa, Vladivostock and Kertch, but precise data about these are lacking.

REVIEW OF THE AMERICAN PRESS

Engineering in Modern Buildings.

AMONG the papers presented at the Washington meeting of the American Society of Mechanical Engineers there are three which indicate to a marked degree the extent to which engineering work enters into modern buildings, especially in the United States. The modern tall business building is a veritable power-house, and the paper of Mr. R. P. Bolton, on the equipment of tall office buildings in New York City, gives an excellent idea of the extent and nature of the mechanical appliances required for these and similar structures. The other two papers referred to are devoted to a different line of work, namely, the power plants of educational institutions; one, by E. A. Darling, being a very full account of the mechanical plant of the new buildings of Columbia University, at New York, and the other, a description, by Professor Storm Bull, of the central heating plant of the University of Wisconsin.

The modern office building has to be warmed, lighted, and provided with vertical transportation in the form of elevators; and to these requirements may be added in some cases mechanical ventilation, so that there are to be found in the basements of these buildings steam plants of 400 to 7 horse-power, electric generators, accumulators, pumps, and a great variety of small machinery, all demanding the skill of a competent engineer in the original design, and the care of several mechanics in daily operation.

Until recently the importance of the engineering features has not been sufficiently considered in the original design of such buildings, and the engineer has been called in to plan the equipment long after the general arrangement of the space has been decided, or even after the building is partly completed. He then finds insufficient space for boilers, piping and transmission, and often inadequate planned and badly placed chimneys, and numerous inconveniences which might have been avoided, all preventing the most advantageous arrangement and operation of the machinery which has become such an essential part of the work. The fact that the consulting engineer is now being called in at a much earlier stage of the work is a gratifying evidence of the appreciation by both owner and architect of the fact that such buildings are really engineering works. The steel framing, the fire-proof arches, flooring, and lathing, the massive foundations, and nearly all the structural details must pass under the eye of a competent engineer, and last, but not least, the operative machinery, forming so large a portion of the equipment, demands his best attention.

If these facts are true with regard to office buildings, they are even more so in connection with the aggregations of buildings which have grown to form the shelter and housing of great educational institutions. Here there are not only the functions of warming, lighting and ventilation to be fulfilled, but in most cases complete machinery shops, mechanical and physical laboratories, to be operated, and general experimental work to be performed. Added to this we have in most cases a number of detached buildings, all requiring varied service, and many of them situated at a distance from the power-house from which all are to be served.

In the case of the power plant of Columbia University, at New York, which is so fully described by Mr. Darling, the new start made by the removal of the University to another location, and the entire construction of new buildings, gave a scope for original plans and the exercise of engineering discrimination not usually possible. The plant is also of especial interest in that it was worked out by the unique combination of a most capable firm of architects acting in conjunction with the engineer by whom it was afterwards to be superintended and operated, and with the aid of the best consulting experts who could be obtained in the departments of electricity, warming and ventilation. The result is a power plant

of the most complete and comprehensive character, one which is planned for the future, as well as the immediate present, and one which had the great advantage of being conceived as a whole, with all the data clearly marked out in advance. It may be of interest to note that Mr. Darling estimates that the cost of the power plant and its connections, including the entire operative engineering equipment, represents about 10 per cent. of the total investment in the buildings which it is intended to supply.

Professor Bull's paper shows the other side of the subject, and unfortunately the side which the engineer is most frequently called upon to contemplate, i. e., the construction of a plant to meet conditions which already exist, and which are by no means those which he would have advised had he been consulted at the start. It is an excellent study, however, of the manner in which local difficulties may be overcome, and includes some useful data and results of tests.

The presentation of those papers before such a convention is an excellent indication of the broadening scope of the work of the mechanical engineer, including, as it does, the work formerly limited to either the architect or the civil engineer, but now become more and more mechanical in character, methods, and object.

Tests of Steam Coals.

THE question of the thermal value of a coal for steam-making purposes is one of great importance to the mechanical engineer, but until recently the only reliable tests on record were those made many years ago upon a limited number of coals. The recent activity in this line of research is very fully discussed in a paper upon comparative tests of bituminous steam coals, presented before the American Society of Civil Engineers, and published in the *Proceedings* of that Society.

After referring to the papers presented before the American Society of Mechanical Engineers by Carpenter, Barrus, Lord, and others, Mr. Hill proceeds to describe the extensive tests made under his direction for authorities of the city of Cincinnati. These tests included a practical steam trial of each kind and grade of coal, under uniform conditions, for a period of sixteen hours; a proximate analysis of each kind of coal; and a calorimetric determination of the heating power of each. The physical tests were made by burning from 18,000 to 25,000 pounds of coal upon the grates of a pair of Galloway boilers, and measuring the evaporation by means of carefully calibrated water-meters.

Fifty-four kinds of coal were tested, of which thirty-three were from West Virginia, fourteen from Pennsylvania, and the balance from Ohio, Kentucky, and Tennessee. The results from these coals, which are grouped by localities, are very fully tabulated in Mr. Hill's paper, and from the tables most valuable data may be obtained for the future in connection with the use of these different varieties.

It is not supposed or claimed that the results indicate the best possibilities with these coals but they do indicate what may be expected in daily practice, with careful firing by the usual force of men such as are employed in the city water department.

The calorimetric determinations of the heating power of the various coals were made with the Carpenter calorimeter, this, after careful investigation, having been found acceptable. The instrument is really a very large thermometer, the fuel being burned in the bulb in the presence of pure oxygen under pressure, all the heat being absorbed by the fuel or lost in radiation. Tests made with foundry coke and with pure carbon, enabled the instrument to be calibrated for losses, and determined its accuracy within permissible limits of error. The proximate analyses gave the proportion of moisture, volatile matter, fixed carbon, and ash, and enabled the calorific power to be computed independently, thus furnishing interesting comparative data.

An interesting portion of Mr. Hill's paper is devoted to the discussion of the heating value of various coals, plotted as a curve, as suggested by Mr. William Kent, using data from Mahler, Lord and Haas, Carpenter, Hale and Williams, and the tests of Mr. Hill above described. Mr. Kent's curve was intended to give a mean of the various tests in such a manner that the calorific value of any coal could be graphically determined by inspection by knowing

the percentage of fixed carbon in the net combustible, but the actual heating power of the coals tested by Mr. Hill was decidedly lower than that which would be assigned to it by the Kent curve. Mr. Hill thinks that this can hardly be explained by errors in his results, but observes that the general application of Kent's curve may be limited by the variable nature of the volatile matter in bituminous coals, these having a material effect on the calorific power and not being included in the data required by Mr. Kent.

It is impossible, in the limited space here available, to do more than indicate briefly the nature of the results obtained by Mr. Hill's tests, and they can only be regarded as comparative with each other so far as the actual evaporative power is concerned. None of the coals gave an evaporative efficiency under the boiler of more than 66 per cent., and the majority of them were below 60 per cent., and although the boiler and furnace were supposed to be in good condition, Mr. Hill admits that some of the coals were worked at a disadvantage. There is no doubt that better results would be obtained for bituminous coal with greater space above the grate than is possible in an internally-fired boiler, such as that in which these coals were tried. Still the completeness of the tests and the fullness of the data accompanying Mr. Hill's paper render the whole a most valuable contribution to the science of steam generation, and the complete record will undoubtedly be freely used hereafter, both for commercial and technical purposes.

The Engineering Profession.

In the course of an address delivered by Mr. John Sterling Deans, before the students of Lehigh University, and published in the *Engineering Record*, some most excellent remarks are made which bear upon the work of the engineer at large, and are not limited to the especial field which Mr. Deans discussed. Some of the best points made are those which bear upon the education of the engineer and upon the manner of his entrance upon the active practice of the profession.

"Engineers are often spoken of as narrow and as only being able to talk shop; if there is any truth in this assertion it may be traced to a lack of a general and broad education in those branches and studies outside of his special work. Whenever possible, let no opportunity be neglected which tends to increase general knowledge and which will assist in laying a broad and thorough foundation for a general education. It is the feeling and belief of the average technical student that the time spent on classical studies, history, literature, and languages is in a manner, wasted, or at least unnecessary. In after years a lack of training in these very branches will be keenly felt by the engineer in his effort to attract attention to his designs and his plans. A profession full of cultured, as well as thoroughly trained, engineers, need have no fear of its standing in the word at large, and that fees of proper size will be expected and paid as cheerfully as to the lawyer or doctor."

In speaking of the commencement of practical life after the college course is finished, Mr. Deans says:

"When taking this first step from college it is most important to shun influential friends who have it in their power to place you in positions beyond your experience; remember it is just as important to progress step by step in the practical work in your profession as it is to follow your regular course in the university."

After the shop and field experience has been gained, the drawing room is the next place to enter.

"The engineering profession may be called the exact profession; probably no other profession can lay claim to the title with the same warrant. The young engineer who has learned to be accurate has made a long step in advance. This is the first habit to be acquired in the drawing room. A beautiful drawing is not essential; a correct one is an absolute necessity. A proper drawing or many drawings might make experience in detailing takes time; one drawing or many drawings might make simply a good draftsman, but it requires many months of actual work at the drawing table to make a good engineer."

One of the best points made by Mr. Deans is the seeming paradox that "after one thoroughly knows how certain work should be done it is no longer necessary for him to do it himself." This may not be

true for all men; if it were there would be no specialists, but it is certainly true for the all-round general engineer or business man. The great thing to be acquired is the knowledge of how other people should do their work so that plans may not only be properly made, but their execution properly supervised.

The ability to write and speak clear lucid English is an acquirement of special value to the engineer, and one which too many of them often lack. It is a well known fact that in the technical and professional societies there are many men of broad and valuable experience who are silent at discussions, and whose names do not appear among the writers of papers. This is mainly because of the diffidence which necessarily accompanies a feeling of inability of expression. The well-educated engineer should not only know how to do things, but he should also be able to set forth what he intends to do beforehand, and to describe what he has done after the work has been accomplished. The man who can show to the interested parties that he knows what he is about, has a far better chance of professional success than his silent companion who may be his superior in ability, but who cannot give expression to his ideas.

Progress in the Iron and Steel Industry.

A GENERAL review of the progress made in the United States during the past ten years in the production of iron and steel, and especially in the reduction of costs, formed the subject of the presidential address of Mr. Charles Kirchhoff at the recent convention of the American Institute of Mining Engineers, and some very interesting points are given. Data furnished from furnaces in the South, in the Pittsburg district, and east of the Alleghenies, all show the material reductions which have been made in costs, together with a greatly increased output.

Thus in the central West the labor cost has been cut down to 46 per cent. of what it was ten years ago, while the coke consumption has been reduced to 86 per cent of the former amount, and the general cost, exclusive of raw materials, has been brought down to 44 per cent. of that of a decade ago. A similar comparison shows the reductions which have been made in costs of Bessemer ingots, the total cost per ton having been reduced to 64 per cent. of the earlier amount, while the labor cost is only 75 per cent. of what it was. It is interesting to note that with the general reduction in the total cost, and with the reduced labor cost, there has been an increase of 25 per cent. in the steam cost, showing that it pays to spend money for steam power, presumably to perform the work upon which labor has been saved.

The general sources of the reductions in mining costs are summed up by Mr. Kirchhoff as follows:

"1. Improved methods in mining, by which a larger percentage of coal is recovered. By concentrating the operations a reduced cost for haulage and maintenance of mine tracks is effected.

"2. Improvements in mechanical haulage appliances, like pneumatic haulage, the endless-rope system and the tail-rope system. With the introduction and extension of these there has been coupled an improvement in the character of mine tracks by better grading, the use of heavier rails, the employment of larger ties and of better equipment generally. This has resulted in increased loads, higher speeds, and consequently a larger output at reduced cost per ton for hauling, and has more than compensated for the increased length of haul due to the retreating of the mine workings from the pit mouth.

"3. Improvements due to taking advantage of gravity in hauling loaded and empty cars at the shafts, and to the introduction of automatic dumping appliances on the tipple.

"4. Improvements in mine drainage by judicious concentration, by installing larger pumping appliances, and by the substitution of compressed air for steam for the purpose of draining points in the mines remote from the power plant.

"5. The substitution of steam locomotives and endless gravity rope appliances for mule power for conveying the coal from the bins to the ovens and charging the latter.

"6 The increased output of the coke ovens by increasing their size and by more carefully and scientifically operating them.

"A highly significant statement in connec-

tion with this interest is that while from 1887 to 1897 the cost fell from 100 to 87.3, the earnings of labor increased from 100 in 1887 to 112.5 in 1897."

It is a question whether the progress in the future will be as marked as it has been in the past. When the same methods are continued it is evident that the rate at which economies can be effected must be a continually diminishing one. When, however, the advances are due to the introduction of new methods, it is difficult to place limitations upon the possibilities.

It is only necessary to point to the use of electric appliances in coal mining, to the introduction into the United States on a large scale of European by-product ovens, to the rapid developments lately of the slag cement industry, to the utilization of the blast-furnace gases for power production, to the continuous open-hearth process, and to the latest achievements in rolling-mill work.

Technical knowledge is becoming more and more a common possession of all producing countries. The race is one in which one and then the other contestant is in the lead. The strain of competition is becoming more and more severe. That under such circumstances the mining engineer will not in the future crowd the records of the past it is difficult to believe.

The Problem of Electrolysis.

THE rapid introduction of electric trolley systems has rendered the question of injury to underground water-pipes by electrolysis a problem of ever increasing importance, and in a leading editorial the *Engineering Record* calls attention to the magnitude of the evil.

The first evidence of the straying of electric currents was that of the effect upon telephone circuits and it finally became apparent that the only remedy was the use of all-wire metallic circuits, thus taking the telephone system out of the reach of the leakage currents from the rail returns of the trolley lines.

If the stray currents were injurious to the telephone lines they are far more damaging to water-pipe systems, and the consequences are apt to be much more serious. Any interruption to the water service of a city is far-reaching in its consequences. Power plants would be shut down for lack of water for the boilers; industries would largely come to a standstill and the inconvenience of the first few days would soon become full of menace to the public health.

The causes and action of electrolysis are well understood, and there is nothing mysterious about it. The return current will not only take the path of least resistance, but it will divide itself between several paths in inverse proportion to their respective resistances. If the earth is dry and the track is well bonded, most of the current will return through the latter, but some of the current will pass through the earth. In case the track is of the poorly bonded type, still to be seen in many places, then the proportion of current running through the earth will be greater. The water pipes, being wholly of metal, are the best of conductors, and if they are in the earth in the vicinity of the track the current makes for them.

"It has been shown by a number of engineers that the double trolley system is the only positive remedy for electrolysis. In that system, whether the wires are overhead, as in Cincinnati, or in conduits, as in several cities, the chances for any leakage of current to the ground are infinitesimal. The overhead double trolley is unsightly, and the network of wires is not regarded with favor by fire departments or insurance underwriters. The conduit system is expensive, too expensive for use in many localities. It is evident, therefore, that the problem becomes one of minimizing to the utmost the danger to which water mains are exposed by the present single trolley system of operation."

Assuming therefore that the double conductor system cannot be required in all cases, the next best thing must be done. The water pipes are in the ground, and there they must remain, at least until some subway system is constructed to receive them, and even when good bonding is used some portion of the current is bound to leak to the pipes. It seems, in the light of present knowledge, that these currents may be so reduced by proper precautions as to be without danger in most cases. It is equally evident, however, that the distribution system of the city should be

watched with great care to detect any signs of incipient electrolysis.

"Whether the cost of this inspection must be borne by the city or the railway companies is a question for the courts to decide. Electric railways are certainly a great boon and nothing should be done to restrict their construction and operation except for a greater public good. As a rule, however, they pay little or nothing for the right of using the streets, on which their existence practically depends, and it seems but just that they should be made wholly responsible, not only for the injury which they have done to water-works systems, but also for preventing further injury in the future."

The Theory of Architectural Proportion.

THE fourth and last of a series of articles of peculiar interest to engineers has just been published in the current number of the *Architectural Record*, under the title "Principles of Architecture." It is of value to engineers in acquainting them with a view-point hitherto to them unknown, the view-point of one who looks at his creation solely with regard to its appearance; and in the attempt that these articles make to reduce æsthetic considerations to some approximation to a scientific order and nomenclature, we think they will have the sympathy of the scientifically minded, who have rather been disposed to look askance at the arts of design, owing to their apparent incoherence, and irregularity. That design, æsthetic design, is not quite irreducible to rule, these articles conclusively show. Moreover, they are unique in that it is the first time in the history of art that such an attempt has been made; no other book that handles the subject in this way being in existence.

All discussions of the principles of design in architecture have inextricably mixed up æsthetic, and constructive, and antiquarian ideas, but here is an author who discusses the looks of things without ever hinting at their construction, and eschewing reference to "style," that idol of architects, in a way that is refreshing.

On the contrary the illustrations, which are many, are drawn from all times and countries, in closest juxtaposition, set forth as examples of large masses or small masses; pointed, square and round masses, and so on.

Perhaps the best part of the treatise is that in which the author tries to show, with some success, that a pleasing proportion between the parts of a building is coincident with some approach to a geometrical similarity in their dimensions, whether in direct or inverse ratio: from its pages at least engineers can learn that which differences their profession from architecture; possibly even they may learn to regard the introduction of a pleasing appearance in constructional work as less irrational and unworthy of consideration than they have hitherto deemed it.

Compound Locomotives.

A PAPER read before the Western Railway Club upon the subject of compound locomotives on the Northern Pacific Railroad, contains some very practical information concerning the actual value of compound locomotives in various branches of service.

It has been assumed in some quarters that the cost for maintenance would be greater for compound than for simple engines, but the experience of Mr. Herr shows that this is not the case. On the contrary, the cost for maintenance, or running repairs, of the compound engines built within the past two years has not been greater than that for simple engines in similar service. Of course the advantage to be expected in the use of the compound engine is that of fuel economy, and the fact that the compound engine does show an economy of about 20 per cent. is now generally conceded. Many railroad men, while freely admitting that the compound locomotive will prove more economical in the consumption of coal in heavy freight service than simple engines of the same weight, do not advocate the compound locomotive for such service because of its assumed liability to failure on account of breaking down, increased cost of maintenance and consequently longer enforced idleness. This view of the case is not sustained by the experience on the Northern Pacific Railroad. Not only are the break downs few, but when they do occur they are rarely due to failure of portions of the mechanism, peculiar to the compounding, but might equally well have occurred with simple en-

gines. Investigation shows that the cost of maintenance is not on account of broken intercepting valves, leaky receivers, or difficulty in packing or counter balancing the low pressure cylinder. Failures occur on account of broken frames, broken cylinders, unequal wear on the low and high pressure sides of the engine, broken piston rods, cut and badly worn cylinders, and other causes, all of which are clearly traceable to either bad design, construction, or improper care in maintenance. Under these circumstances it is rather an admission of inability to cope with the problems of proper design and maintenance, to refuse to use such a machine because it breaks down.

Admitting the value and economy of the compound system, it seems rather the duty of railroad officials to study the causes of failure, and to remedy the defects which actually appear, so that the weak points may be remedied and a compound locomotive designed which will not fail in service.

The real defect in the compound system, as applied to the locomotive, and indeed in other service, is its lack of flexibility. The economy which is attained by the compound locomotive is at its best when running at a uniform load, a load for which it was designed. When a compound engine is worked under a light load its economy is very much reduced, and for a varying service the simple engine may be found more satisfactory. Compound locomotives have been found very advantageous in heavy fast passenger service, especially so in the very fast service. The reason of this lies in the fact that it is in this service that the boiler is taxed to the utmost, the greatest amount of horse-power is required, and it is necessary to use the steam to the best advantage.

The experience on the Northern Pacific Railroad was gained by putting compound engines on a portion of the divisions, and then by changing the simple engines with the compounds, and thus obtaining a comparative idea of the relative performances of the two types under similar conditions. The result of these trials was that the compound engines did not show any material advantage on the light service, but that for steady, heavy work, on level divisions, where there is a steady pull upon the boiler for steam, and no chance to pick up pressure while running down grades, the compound engines showed very clearly the benefit of their economical use of steam.

The experience on the Northern Pacific Railroad was mainly with two-cylinder compound engines, but experience with Vauclain four-cylinder compounds on the Chicago, Milwaukee and St. Paul road and elsewhere, have shown a fuel-saving of 17 per cent., and nearly a similar economy in reduction of charges for repairs. So far as speed is concerned, it will be remembered that on the Philadelphia and Reading Railway the fast train to Atlantic City, which holds a phenomenal record for speed, has, for several seasons, been drawn by a four-cylinder compound.

The Chicago Drainage Canal.

THE opposition which the city of St. Louis has developed against the pollution of the waters of the Mississippi by the sewage of Chicago, has culminated in a report of a committee appointed for the purpose of setting forth the true state of the matter so far as it can at present be ascertained. This report, while primarily intended to express the protest of St. Louis against what is believed to be a serious menace to the health of that city, is also an interesting discussion of the problems of sewage removal of great cities, and the methods which may be adopted to remove and dispose of sewage without injury to public health.

The Chicago drainage canal, now nearly completed, is to connect the South Branch of the Chicago river to the Desplaines river at Lockport, whence it will flow to the Mississippi. All the sewage now flowing into Lake Michigan is to be intercepted and turned into the Chicago river together with a volume of 20,000 cubic feet of water per minute from the lake, to assist in producing a current and to dilute the sewage. Four results are expected to follow the completion of the drainage canal. 1. Protection of Chicago's water supply from pollution; 2. Purification of the Chicago river and its branches; 3. Discharge of flood waters without overflow; 4. Disposal of all the sewage from the population centring in Chicago, without detriment to other communities. The performance of the first

three points may be conceded for the present, but the fourth one is of vital interest to the city of St. Louis, since the discharge of the sewage of Chicago by the canal means its delivery into the Mississippi, from whence St. Louis draws its water supply, at a point only 45 miles above the city.

Commenting on the subject editorially, *Engineering News* says:

"With the canal in operation, discharging 300,000 cubic feet per minute of sewage and water, and assuming one-twelfth of this to be sewage, the minimum flow of the Mississippi river at St. Louis will be to the sewage of Chicago as 91 to 1. If all of Chicago's sewage now went to the Mississippi, which we understand is not the case, although so assumed in the report, the dilution at the minimum river stage would be as 80 to 1. Although the exact figures are not at hand, the amount of sewage sent down to St. Louis when the canal is put in operation will doubtless be considerably more than at present, but it will be far more diluted. At best the dilution now is probably not over 2 or 3 to 1, while with the canal now in operation, the dilution will be 11 to 1. But the report urges that the Chicago river now acts as a septic tank, and that with the canal in use, the sewage will go seaward faster, and thus a larger number of germs will be carried to a greater distance than at present.

Just what the best remedy is for the prospective injury to St. Louis remains to be seen. It is implied that Chicago is bound to purify the sewage before casting it upon the waters to pollute and contaminate the water supply of a neighboring city. When it is considered that a sewage purification plant would cost more than fifty million dollars for construction, and three millions for maintenance this seems like asking a great deal; while on the contrary the question of the right to pollute an interstate navigable water-way is still an open question. It may be stated in reply that St. Louis can purify, by filtration, or otherwise, the Mississippi water, if it is found unwholesome, but this is throwing the burden and cost upon the shoulders of the unoffending party.

As *Engineering News* again says:

"The commission recognizes the position in which its report places St. Louis in the matter of water pollution. It urges that by general laws of the United States the pollution of interstate streams must soon be stopped, and that state and municipal regulations will demand the purification of public water supplies under suspicion. It therefore recommends that St. Louis 'so shape its course as to meet both of these propositions before the necessity for meeting them is forced on the city by epidemics, and drastic measures of the general law.'"

In this connection it must not be forgotten that imperfect sewage disposal may be as potent a cause of disease as a polluted water supply, and that no stringent legislation against discharge into streams will help matters unless accompanied with proper provision for effective disposal of sewage in some other way. The wider extension of the bacterial processes may help to solve the problem, however, and make it possible to accomplish both ends, to the benefit of humanity and the elimination of much disease.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Journal of Science. *m.* New Haven, Conn.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Jour. *m.* London.
Berg-und Hüttenmännische Zeitung. *w.* Berlin.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wisconsin, Madison, U.S.A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Electrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.

Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita, *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, U.S.A.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U.S.A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs and Surveyors. Peoria, U.S.A.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *qr.* New London, Conn.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kans.
La Ingenieria. *m.* Buenos Aires, Argentina.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U.S.A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, U. S. A
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen *w.* Vienna.
Ores and Metals. *w.* Denver, Colo.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, U.S.A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revista de Obras Públicas. *w.* Madrid.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitarian. *m.* Brooklyn, U. S. A.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerische Bauzeitung. *w.* Zürich
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, U. S A.
Stahl und Eisen. *s-m.* Düsseldorf.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, U. S. A
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston.
Terrestrial Magnetism. *qr.* Cincinnati, O.
Trans. Assn. C. E. of Cornell Univ. Ithaca, U. S. A.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Engineers. *m.* New York.
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Western Railway Club Pro. Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, U. S. A.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutcher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Chimney.

A Cincinnati Steel Chimney. Illustrated description of the details of a 230 ft. steel chimney. 1600 w. Eng Rec—April 1, 1899. No. 26886.

Cold Storage.

Construction of a Cold Storage Building. From *Carpentry & Building*. Illustrated description of a building erected at Fort Sheridan, Ill. 700 w. Met Work—April 22, 1899. No. 27126.

Elevators.

See Mechanical Engineering, Machine Works.

Exposition.

Exposition of 1900. Civil Engineering and Transportation Buildings. (Exposition de 1900. Palais du Génie Civil et de Moyens de Transport.) R. Weil. Especially devoted to the methods of raising the frames and erecting the structural work of these important portions of the exposition buildings. 3500 w. 1 plate. Génie Civil—March 18, 1899. No. 27211 D.

Fire-proofing.

Effects of Heat upon Natural Stone and Burnt Clay. Charles J. Everett. Gives a report of investigations made after great conflagrations, also giving opinions of others. 2800 w. Br Build—March, 1899. No. 26910 C.

Fire Stops.

The Massachusetts Rules for the Provision of Fire Stops in Buildings. A copy of the specifications covering the requirements for preventing the spread of fire in buildings, with comments. 1200 w. Eng News—April 6, 1899. No. 26945.

Hospitals.

Massillon State Hospital. Illustrated description of the grounds, buildings, heating, ventilation, plumbing, water supply and sewage disposal of a large Ohio institution for the insane. 2000 w. Eng Rec—April 15, 1899. Serial. 1st part. No. 27046.

The Buffalo General Hospital. Illustrates and describes the structural and hygienic features of a large hospital building recently opened. 2000 w. Eng Rec—April 8, 1899. No. 26962.

Kursaals.

Continental Kursaals. Brief description of these public assembly halls at the various resorts. 2300 w. Arch, Lond—March 31, 1899. No. 26991 A.

Libraries.

Public Libraries. J. M. Brydon and F. J. Burgoyne. The paper by Mr. Brydon discusses what has recently been done in library building, giving illustrations. Mr. Burgoyne considers the planning and fitting. Discussion. 13000 w. Jour Roy Inst of Brit Archts—Feb. 25, 1899. No. 26926 D.

Moving Buildings.

Moving an Iron Building in Paris. Describes the method employed in moving the framework of a 98 x 492 ft. building a distance of about 850 ft. Eng Rec—April 8, 1899. No. 26966.

Office-Buildings.

The Equipment of Tall Office Buildings in New York City. Reginald Pelham Bolton. The construction of so many buildings of this character has brought about a competition that makes the economical equipment and operation of importance. This subject is discussed and some of the problems presented. Ill. 4800 w. Trans Am Soc of Mech Eng—May, 1899. No. 27301 D.

The Machinery of a Great Office Building. F. E. R. Illustrates and describes the elevators, engines, generators and heating system of the Ivins Syndicate Building, in New York. 3400 w. Mach, N. Y.—April, 1899. No. 26844.

Stable Construction.

The Wanamaker Stables, New York. Illustrated description of the buildings employed by a large retail dry-goods house for its delivering department. 2100 w. Eng Rec—April 22, 1899. No. 27137.

Steel Framing.

Column and Beam Connections in the Williamson Building. Illustrates new details adopted in a Cleveland office building, 16 stories high. 450 w. Eng Rec—April 22, 1899. No. 27135.

Towers.

The Theory of Dome and Tower Construction. (Zur Theorie der Kuppel und Turmdacher.) H. Müller-Breslau. A further discussion of the principles of framing the members of metal domes and spires, and the computation of stresses therein. 5,000 w. Zeitschr d Ver Deutscher Ing—April 8, 1899. No. 27207 D.

Workmen's Homes.

Dwellings for the Working Classes Financially Considered. Peter Fyfe. From a lecture delivered before the Glasgow and West of Scotland Architectural Craftsmen's Society. An examination of various dwellings to determine whether sanitary homes can be rented to this class without financial loss to the owners. 3300 w. Brit Arch—April 7, 1899. No. 27066 A.

HEATING AND VENTILATION.

Heating Plant.

The Central Heating Plant of the University of Wisconsin, at Madison, Wis. Storm Bull. Describes the plant, with tests, of interest because of the difficulties overcome. Ill. 7400 w. Trans Am Soc of Mech Engs—May, 1899. No. 27300 D.

Hospital.

Heating and Ventilating Fletcher Hospital, Kalamazoo, Mich. Illustrates and describes a fine installation. 1500 w. Heat & Ven—April, 1899. No. 27183.

Hot-Air Furnaces.

The Metal Worker Hot-Air Furnace Competition. Albert N. Parker. The first prize essay of a competition for heating a school building with hot-air furnaces. Ill. 2500 w. Met Work—April 1. 1899. No. 26843.

Interior Ventilation.

The Working of Ventilation Systems. Comment on the report of W. N. Shaw, to the Local Government Board, England, concerning the ventilation and warming of dormitories, workshops and schools. 1800 w. Jour Gas Lgt—April 4, 1899. No. 27053 A.

Modern Practice.

Modern Practice in Steam Heating and Ventilation. William S. Monroe. Chapter first describes the methods used in heating buildings of different classes and is introductory to more detailed information. 2200 w. Eng Rec—April 15, 1899. Serial. 1st part. No. 27047.

PLUMBING AND GASFITTING.

Drainage.

House Drainage and Sanitary Fitments. Gerard J. G. Jensen. Chapter first considers form and materials of piping for drainage work. Ill. 1500 w. San Rec—April 7, 1899. Serial. 1st part. No. 27065 A.

London By-Laws as to the Drainage of Buildings. A copy of the proposals now under consideration, with editorial comment. 9800 w. Builder—April 1, 1899 No. 26995 A.

Master Plumbers.

The Position of the Master Plumber as Regards the Sewerage of Cities and Towns. James F. Traynor. Read at the New Orleans convention. The work of the plumber in connection with water supply, sewerage, general sanitation, etc. 2500 w. San Plumb—April 15, 1899. No. 27138.

Public Baths.

The Municipal People's Baths of Vienna. W. P. G. Describes two of these bath-houses, giving illustrations of details. 2700 w. Arch & Build—April 15, 1899. No. 27023.

Sanitation.

The Sanitation of Dwellings in England. Barrister F. Fletcher. The present article deals with the site, the drainage, and the heating, lighting and ventilation. 3300 w. Arch Rec—April-June, 1899. No. 27182 C.

Sewerage.

Perfect Sewerage in Relation to Public Health. James J. Wade. Read before the Nat. Ass'n of Master Plumbers, at New Orleans. Showing the dependence of public health upon perfect sewerage and plumbing. 2200 w. Dom Engng—April, 1899. No. 27108 C.

Perfect Sewerage in Relation to Public Health. Louis F. Meyer. The work of the plumber in the prevention of disease, and in promoting sanitation. 1700 w. San Plumb—April 15, 1899. Serial. 1st part. No. 27139.

Sutro Baths.

Sutro Baths of San Francisco. F. W. Parsons. Illustrated description. 700 w. Sci Am—April 29, 1899. No. 27318.

MISCELLANY.

Building Stone.

See Civil Engineering, Materials.

Chemistry in Building.

Chemistry as an Aid in Building. Calls attention to the subjects connected with building with which chemistry is associated. 1300 w. Builder—April 8, 1899. No. 27069 A.

Composition.

Principles of Architectural Composition. John Beverley Robinson. The last of a series of articles showing that a pleasing appearance in constructional work is worthy the consideration of engineers, and discussing the principles of design. Ill. 5500 w. Arch Rec—April-June, 1899. No. 27328 C.

Glue.

Glue Testing. S. Rideal. Gives the chemical examination and physical tests, etc. 4000 w. Builder—April 15, 1899. No. 27157 A.

CIVIL ENGINEERING

BRIDGES.

Alexander III.

Notes on the Construction of the Alexander III Bridge. (Notes sur la Construction du Pont Alexandre III.) MM. Résal and Alby. A further contribution to

the account of this great work; dealing principally with the construction of the hinged arches and with their erection. 16000 w. 5 plates. Ann des Ponts et Chaussées—4 Trimestre, 1898. No. 27227 E + F.

The Construction of the Alexander III Bridge, Paris. Jacques Boyer. A very fully illustrated account of the design, construction and erection of the latest and most remarkable bridge across the Seine; one of the conspicuous features of the coming exposition. 4500 w. Engineering Magazine—May, 1899. No. 27283 B.

Arch.

A Stone Arch Bridge of Moderate Cost. Illustrates a small stone arch built at Kankakee, Ill. 300 w. Eng News—March 30, 1899. No. 26862.

Budapest.

The Schwurplatz Bridge over the Danube at Budapest. (Die Schwurplatz-Donaubrücke in Budapest.) A. Meissner. Description of this new chain-suspension bridge over the Danube, with plate of details and map of approaches. 2000 w. 1 plate. Oesterr Monatschr f d Oeffend Baudienst—April, 1899. No. 27221 D.

Concrete.

The New Stauffacher Bridge at Zurich. (Die Neue Stauffacher-Brücke in Zürich.) The engineer's specification, with details and elevation of this handsome béton arch of 130 feet span. 2000 w. Schweizerische Bauzeitung—March 4, 1899. No. 27247 B.

Falsework.

Failure of Falsework of New York Bridge. Illustrated description of bridge falsework which fell April 11, killing five men and injuring over twenty. 600 w. Eng Rec—April 15, 1899. No. 27039.

Foundations.

The New York Tower Foundations, New East River Bridge. Illustrated account of the method of constructing these piers,especially the means for working under compressed air. Several new forms of air locks are explained. 2000 w. Eng Rec—April 1, 1899. No. 26882.

Glasgow.

The New Glasgow Bridge. From the *Scotsman*. General description of the work of rebuilding of a bridge over the Clyde. 1100 w. Archt, Lond—April 14, 1899. No. 27155 A.

Korea.

A Korean Bridge. Illustrated description of the first steel bridge in Korea, a railway structure having a footway outside one truss. The bridge is 2,000 ft. long and has ten spans. 700 w. Eng Rec—April 15, 1899. No. 27036.

Loads.

General Criterion for Position of Loads Causing Maximum Stress in Any Member of a Bridge Truss. F. H. Cilley. Contribution to the discussion of the paper by L. M. Hoskins. 400 w. Pro Am Soc Civ Engs—April, 1899. No. 27308 E.

Railroad Bridge.

Erection of Bridge 69, Pennsylvania Railroad. Illustrated description of the methods employed in erecting a bridge of 236 ft. span on one of the busiest trunk lines in the country without the interruption of traffic. The new span was erected on falsework on one side of the line and when it was completed the old span was moved to the other side and the new one substituted, the time occupied in moving being less than 14 minutes. 3600 w. Eng Rec—April 22, 1899. No. 27128.

Reconstruction.

Reconstruction of the Penrose Ferry Bridge, Philadelphia. Illustrated description of some novel foundation methods for bridge piers and of heavy timber approaches. 2800 w. Eng Rec—April 8, 1899. No. 26959.

Reinforced Concrete.

The X Bridge at Mans. F. E. R. From *La Revue Technique*. Describes a bridge of originality of construction and pleasing appearance. Ill. 2800 w. Ind. Engng—March 25, 1899. No. 27173 D.

Rhine Bridges.

The Bridges Across the Rhine, Near Bonn and Dusseldorf, Germany. Fritz Mueller von der Werra. Illustrates and describes the important features of two imposing structures opened to traffic in 1898. 4300 w. Eng News—April 20, 1899. No. 27110.

The New Rhine-Bridges at Bonn and Dusseldorf. (Die Neuen Rheinbrücken zu Bonn und Düsseldorf.) A comparative study of these latest bridges across the Rhine, with numerous details of the construction. 7500 w. 1 plate. Zeitschr d Ver Deutscher Ing—March 25, 1899. No. 27203 D.

CONSTRUCTION.

Dams.

The Construction of High Earth Dams. Review of a paper by W. L. Strange before the Inst. of Civ. Engs., and of the discussion it elicited. 6000 w. Eng Rec—April 15, 1899. No. 27043.

The Periae Dam. J. S. Chandler. Illustration and brief description of this great dam in India, which provides irrigation for 150,000 acres of land. 500 w. Sci Am Sup—April 8, 1899. No. 26935.

The Resistance of Dam Framing. (La Résistance de Fermettes de Barrages.) M. Claise. Giving the results of tests of the strength of the frames used to support the sections of a movable dam of the needle type, and the method adopted to increase

stiffness. 3000 w. 1 plate. Ann des Ponts et Chaussées—4 Trimestre, 1899. No. 27-228 E + F.

Foundations.

The Calculation of I-Beam Grillage Foundations. J. B. Nau. Submits an easy and rapid method of making these calculations, giving diagram. 1000 w. Eng News—April 20, 1899. No. 27112.

Reinforced Concrete.

Construction in Reinforced Cement. (Constructions en Ciment Armé.) N. de Tedesco. A paper before the Society of Civil Engineers of France, giving the latest advances in reinforced concrete construction, with data of tests. 5000 w. Soc Ing Civ de France—Jan., 1899. No. 27-235 G.

See also Bridges.

Roads.

Use of Tar in Road Making. A. H. Campbell. Extract from a paper read before the Assn. of Munic. and Co. Surv's, on the construction of roads of tarred macadam. 2000 w. Gas Engs' Mag—April 10, 1899. No. 27303 A.

Truss.

Graphical Determination of Maximum Stresses in a Truss. (Graphische Ermittelung der Grössten Stabkräfte in emem Fachwerksbalkentrager.) Prof. J. Melan. Describing a simple graphical method, with diagrams showing the application. 2000 w. Oesterr Monatschr f d Oeffent Baudienst—April, 1899. No. 27223 D.

Tunnel.

The Beach Broadway Tunnel. Illustrates and describes the tunnel built in 1869 under Broadway, New York, and the car used in it. 1000 w. Sci Am—April 15, 1899. No. 27013.

The Proposed Thames Tunnel. Editorial Discussion of the tunnel to be constructed under the Thames from Shadwell to Rotherhithe, making suggestions for improvements. 1000 w. Engr, Lond—April 7, 1899. No. 27087 A.

HYDRAULIC AND MARINE.

Artesian Wells.

Savannah and Its Artesian Wells. Describes the methods adopted to restore the water to old wells when it had failed. 600 w. Fire & Water—April 15, 1899. Serial. 1st part. No. 27062.

Canals.

Physical and Commercial Aspects of the World's Ship-Canals. E. L. Corthell. A critical comparison of the constructive features and operative details of existing ship canals, enabling the possibilities of future undertakings to be studied in the light of previous experience. 4500 w. Engineering Magazine—May, 1899. No. 27-288 B.

The Economic Relation of the Proposed Deep Waterways to the State of New York. George W. Rafter. Reviews the improvements made in transportation by the way of the Great Lakes, Oswego and Mohawk route, especially since the construction of the Erie Canal, and discusses the present project to permit large boats to pass from the Great Lakes to tide water. 3800 w. Tech Quar—March, 1899. No. 27022 E.

The Galops Canal. Illustrates and describes the improvements on this canal in Ontario, with remarks on the general improvement of the canal system. 1100 w. Fire & Water—April 1, 1899. No. 26-894.

The Nicaragua Canal and Its Rivals. Reviews the various bills presented during the last session of the U. S. Congress, and the question as it now stands. 4500 w. Engr, Lond—April 7, 1899. No. 27081 A.

The Report of the St. Louis Commission on the Chicago Drainage Canal. The report in full is given, in view of its interstate and international complications, and the discussion of the engineering and legal principles. 6000 w. Eng News—April 27, 1899. No. 27342.

The Soulanges Canal. Describes the 14-mile canal passing boats of 2,000 tons on a 14-ft. draft around Cascades, Split Rock, Cedars and Coteau Rapids in the St. Lawrence River. 1400 w. Eng Rec—April 8, 1899. No. 26958.

Coasts.

Sea-Coast Protection. W. H. Wheeler. Describes the causes of coast destruction and the remedies adopted in various lands. 2200 w. Engr, Lond—April 7, 1899. Serial. 1st part. No. 27080 A.

Dock.

New York, New Haven & Hartford Dock at New London, Conn. E. M. Smith. Illustrates and describes a dock 500 ft. long by 100 ft. wide now being built for the use of passenger and freight trains meeting the boats of the Norwich, Stonington and Fall River lines. 800 w. R R Gaz—April 7, 1899. No. 26950.

Dredges.

Report on Sand-Pump Dredgers. W. R. Haughton. Gives general description with illustrations, and discusses the requirements for working on the Ganges. 2000 w. Ind Engng—Feb. 25, 1899. No. 26849 D.

Filtration.

Filtration at Pittsburg. Extracts from a report of the committee appointed to investigate methods of filtration. Considers sand and mechanical filtration. 1800 w. Fire & Water—April 22, 1899. No. 27181.

Water Filtration, Zurich, Switzerland. James H. Fuertes. Illustrated account of

the filter beds and a statement of the work they accomplish. 1100 w. Eng Rev—April 22, 1899. No. 27130.

Ground Water.

Influence of Rain and Air-Temperature upon the Temperature and Flow of Ground Water. (Abflussmengen und Temperaturschwankungen des Grund wassers in ihren Beziehungen zur Regenhohe und Luftemperatur.) Adolph Friedrich. Tabulated deductions, with diagrams, from data obtained from many observations in Austria. 3000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—April, 1899. No. 27224 D.

The Ownership of Underground Water in New York. Gives the legal views held by the New York courts on the ownership of ground water, and explains the reason for giving an injunction to a farmer to restrain pumping such a supply for municipal use, when refusing an injunction to a rival water-works for the same purpose. 800 w. Eng Rec—April 15, 1899. No. 27041.

Havre.

The Improvement Works at the Port of Havre. (Les Travaux d'Amelioration du Port du Havre.) G. Leugny. With a hydrographic plan of the harbour, and a description of the new dykes and dock basins. 3000 w. Revue Technique—March 25, 1899. No. 27217 D.

Hydrography.

The Information Service of the Vienna Hydrographic Bureau. (Der Wasserstands-Nachrichtdienst der K. K. Hydrographischen Landesabtheilung in Wien.) A full account of the observations of the level of the Danube at various points, and the system of sending out information of floods. 4500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—April, 1899. No. 27222 D.

Ice Shields.

Ice Shields at the Buffalo Water-Works. Illustrated description of the apparatus used at Buffalo to keep stream and anchor ice out of the pumping wells. 500 w. Eng Rec—April 1, 1899. No. 26881.

Lancaster, Pa.

The Water Problem of Lancaster, Pa. A review of the proposed engineering works for conserving, clarifying and purifying the present water supply. 1500 w. Eng Rec—April 22, 1899. No. 27133.

Litigation.

The Reversal of the Danville Water-Works Decision. Reviews an opinion of the Illinois Supreme Court which declares a contract between a water company and a city, running for several years, not binding so far as the schedule of rates in the contract is concerned. 1400 w. Eng Rec—April 8, 1899. No. 26957.

The Rogers Park Water-Works Case. Full text of a decision by the Illinois Supreme Court which declares not binding a contract between a local water company and the town of Rogers Park, now part of Chicago. 3000 w. Eng Rec—April 8, 1899. No. 26965.

Mississippi.

The Problem of the Mississippi. Herman Haupt. A discussion of the problem of maintaining a navigable channel in low water and preventing the destruction of life and property by floods. 3500 w. Jour Fr Inst—April, 1899. No. 26952 D.

Nile.

The River Nile. E. A. S. A sketch map showing the numerous sources of the river is given, and part first gives information concerning the lakes. 1200 w. Ind Engng—March 18, 1899. Serial. 1st part. No. 27144 D.

Philadelphia.

The Water Problem in Philadelphia. Address by Prof. Edgar Marburg, on the reasons for the typhoid fever outbreak in the early months of 1899. Also editorial. 3000 w. Eng Rec—April 8, 1899. No. 26963.

Pumps.

See Mechanical Engineering, Hydraulics.

Purification.

The Purification of Public Water Supplies. W. N. Twelvetrees. Abstract of a paper presented at a recent meeting of the British Civ. & Mech. Engs. Considers filtering media, methods of purification, etc. 1600 w. Jour Gas Lgt—April 4, 1899. No. 27055 A.

Rockford, Ill.

Difficult Engineering Problem Solved in Rockford's New Water-Works. On the difficulties encountered and overcome in the construction of the new water supply plant. Ill. 1300 w. Munic Engng—April, 1890. No. 26892 C.

River Correction.

Improvement Works upon the Arzen-Ain-Sefra Railway, Algeria. (Travaux sur le Chemin de Fer d'Arzew à Ain-Sefra, Algérie.) Showing the application of embankment methods, similar to those employed in Switzerland, for the protection of a railway from damage by river overflow. 1200 w. Génie Civil—March 18, 1899. No. 27212 D.

Stand-Pipe.

New Water Tower at Schenectady, N. Y. Illustrated description of the construction of an enclosed stand-pipe of 6,000,000 gallons capacity. 1000 w. Eng Rec—April 1, 1899. No. 26885.

Submerged Pipe.

Submerged Pipe-Laying at Delray. Illustrated account of method of laying 72-inch pipe across the Rouge River, with description of a special joint for such work. 600 w. Eng Rec—April 15, 1899. No. 27037.

Tides.

The Distribution of Velocity in Tidal Currents. (Distribution des Vitesses dan les Courants de Marée.) M. Bomdelles. A general discussion of tidal currents, as influenced by the configuration and depth of the harbour, based upon numerous observations made in France and elsewhere. 6500 w. 4 plates. Ann des Ponts et Chausseés—4 Trimestre, 1898. No. 27225 E + F.

Water Rights.

New French Law Regulating the Use of Water. Law to regulate the ownership and the regimen of rain water, spring water, and all flowing streams, and to determine the rights of individuals, communities, etc. 1400 w. Eng News—April 13, 1899. No. 27019.

Watershed.

The Fight for the Derwent Watershed. Some details of the three schemes of Derby, Leicester and Sheffield, (Eng.) for obtaining possession of the Derwent and its supply. 1700 w. Jour Gas Lgt—April 18, 1899. No. 27312 A.

Water Tank.

The New Elevated Water Tank at Jacksonville, Fla., R. N. Ellis. Perspective view and detail drawing with description. 1000 w. Eng News—April 27, 1899. No. 27338.

Water Works.

The Amballa Water-Works. Abstract of a paper by Charles E. V. Goument before the Inst. of Civ. Engs. (England), on an Indian Water plant, drawing water from wells, and conducting it to the town through an 8-inch main by gravity and pumping combined; the plant has several unusual features. 2000 w. Eng Rec—April 22, 1899. No. 27132.

MATERIALS.

See also Mechanical Engineering, Materials.

Building Stone.

Building Stones—Elements of Strength in Their Constitution and Structure. Alexis A. Julian. Considers the foundations on which methods of testing should be based to determine their strength. Ill. 10700 w. Jour Fr Inst—April, 1899. Serial. 1st part. No. 26951 D.

Cement.

Government Tests for Cement. A copy of the tests and conditions enforced by the Russian Government, in selection of Portland cement. 1000 w. Stone—April, 1899. No. 27099 C.

Concrete.

On the Theory of Concrete. George W. Rafter. Explanations condensed from the author's report to the N. Y. State Engineer, on tests made, with tabulated results. 2200 w. Pro Am Soc Civ Engs—April, 1899. No. 27306 E.

Mortar.

The Mechanism of the Disintegration of Hydraulic Mortars. (Sur le Mécanisme de la Désagrégation des Mortiers Hydrauliques.) H. Le Chatelier. A note to the French Academy, developing a theory for the hitherto unexplained action sometimes occurring in hydraulic mortar. 1000 w. Comptes Rendus—March 13, 1899. No. 27241 D.

Paving-Brick Tests.

Tests of Paving Brick at the Iowa State College. Illustrated account of experiments to determine the relative importance of different kinds of tests. 3500 w. Eng Rec—April 1, 1899. No. 26884.

Preserving Wood.

Haskinized Wood. Frank Caws. An explanation of this invention for rendering timber decay-proof. 4800 w. Jour Roy Inst of Brit Archts—March 11, 1899. No. 26929 D.

Road Stone.

Description of Apparatus and Methods Used by the Massachusetts Highway Commission in Investigating the Properties of Road Building Stone. Describes the work as carried on in the engineering laboratory of Harvard University. 1600 w. Stone—April, 1899. No. 27098 C.

MEASUREMENT.

Planimeters.

Some Observations on the Use of Polar Planimeters. Walter W. Patch. Notes collected during several years' experience furnishing facts relating to the degree of accuracy of results obtained. 2000 w. Eng News—April 13, 1899. No. 27018.

Survey.

A Great Cadastral Survey. A brief outline of the character and extent of the work which will be necessary in revising and renewing the cadastral survey of France, which is under consideration. 1600 w. Engr, Lond—April 7, 1899. No. 27082 A.

MUNICIPIAL.

American Municipalities.

An English Municipal Engineer's Visit to America. George Livingstone. Read before the Incor. Assn. of Munic. and Co. Engs., London. Notes on traffic, paving, cleansing, dust removal, water supply,

baths, buildings, etc. 9400 w. Builder—April 8, 1899. No. 27070 A.

London, Ont.

The Sewerage of London, Ont. Abstract of a paper by W. T. Ashbridge before the Canadian Soc. of Civ. Engs., on methods followed in constructing sewers under difficult conditions. 1400 w. Eng. Rec—April 22, 1899. No. 27134.

Refuse.

Refuse Destruction. Editorial on the interesting report of Messrs. Kelvin and Barr on the subject of refuse destruction in connection with the Horsfall furnace. 2000 w. Engng—April 7, 1899. No. 27079 A.

Sewage.

Sewage Precipitation Works of New Rochelle, N. Y. H. de B. Parsons. Illustrated description. 1200 w. Stevens Ind—April, 1899. No. 27125 D.

Sewage Disposal.

Sewage Disposal, Kingston-on-the-Thames, England. James H. Fuertes. Illustrated description of a plant treating the sewage of a population of 43,000 by the A B C process, which, in its latest form, is described in detail. 1100 w. Eng Rec—April 8, 1899. No. 26960.

Sewer Repairs.

Sewer Repairs, Cincinnati, O. Describes the method of reconstructing the invert of a 9½ ft. sewer without stopping the flow of sewage. 1000 w. Eng Rec—April 15, 1899. No. 27042.

Sewers.

Maintenance of Sewers at Providence, R. I. Allen Aldrich. Results from an experience of 26 years. Ill. 4800 w. Eng News—March 30, 1899. No. 26860.

Sewer Catch-Basin and Cleaning Apparatus at Wilmington, Del. T. Chalkley Hatton. A brief description of a catch-basin and apparatus invented by the writer, which has proved satisfactory and economical. Ill. 700 w. Eng News—March 30, 1899. No. 26859.

The North Yarra Sewer Tunnel, Melbourne. Illustrated abstract of a paper by H. V. Champion, describing a tunnel in bad soil, driven by means of a shield and compressed air. 4000 w. Eng Rec—April 8, 1899. No. 26961.

Street-Cleaning.

Street Cleaning in Washington. An account of the methods followed in the city named, where both hand and machine cleaning is in vogue. 1400 w. Eng Rec—April 22, 1899. No. 27129.

Street Grades.

Street Grades and Cross-Sections in Asphalt and Cement. J. M. Evans and A. F. Harley. Contributions to the discussion of Robert P. Woods' paper on this subject. 1700 w. Pro Assn Soc Civ Engs—April, 1899. No. 27307 E.

MISCELLANY.

Porto Rico.

Engineering Features of San Juan, Porto Rico. H. M. W. A letter containing a statement of the general character of the engineering work in progress. Ill. 3000 w. Eng News—March 30, 1899. No. 26864.

Wrecking.

The Recovery of a Titan Crane at Mostaganem. (Repéchage d'un Titan à Mostaganem.) I. Pronteau. An account of the recovery of a powerful crane which had been blown into the sea from a breakwater at Mastaganem, Algeria. 1200 w. Revue Technique—March 25, 1899. No. 27215 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Bandot System.

The Bandot System of Telegraphy. E. Bernard. Illustrates and describes this printing telegraph system which has been adopted by the French Government, and is used also in other countries of Europe. 1600 w. Elec Rev, N Y—April 12, 1899. No. 27024.

Coherer.

A Very Sensitive Coherer. (Sur un Cohéreur Très Sensible.) T. Tommasina. A communication to the French Academy describing a very sensitive coherer composed of granules of carbon between carbon points. 1000 w. Comptes Rendus—March 13, 1899. No. 27242 D.

Exchanges.

Automatic Telephone Exchanges. Describes briefly the system as applied to a small exchange of one hundred subscribers. Ill. 1300 w. Builder—April 15, 1899. No. 27156 A.

Foreign Service.

The Telephone Service in Foreign Countries. Information obtained by British Consuls is summarized. 4000 w. Elect'n, Lond—March 24, 1899. No. 26870 A.

Italy.

The Telephone in Italy. (La Telefonia in Italia.) Giacinto Motta. An address showing the extensive use of the tele-

phone in various countries and comparing the progress made by Italy with other parts of the world. The formation of one general organization for the whole of Italy is urged. Two articles. 7500 w. L'Elettricita, April 1, 8, 1899. No. 27271, each B.

Pacific Cables.

The Coming Pacific Cable. Considers the chief physical and mechanical difficulties of the undertaking, with comments on the possibility of the enterprise being put through by the United States rather than by Great Britain. 1700 w. Ind and Ir—March 24, 1899. No. 26871 A.

Paper Cables.

Paper Cables as Used in Telephony, etc. E. J. J. Illustrates and describes the method of applying paper insulation, the laying of the cables, construction of the terminals, etc. 2200 w. Elec Rev, Lond—April 7, 1899. No. 27073 A.

Space Telegraphy.

Telegraphing Without Wires. (Télégraphie sans Fil.) Paul Janet. A discussion of currents of high frequency and electrical oscillations, especially in connection with the experiments in space telegraphy in Paris by M. Ducretet. 5000 w. Soc Ing Civ de France—Feb., 1899. No. 27-238 G.

Wireless Telegraphy. J. A. Fleming, in the London *Times*. On the importance of Signor Marconi's methods and the results he has brought about. 900 w. Ry & Engng Rev—April 22, 1899. No. 27177.

Wireless Telegraphy. Rankin Kennedy. An explanation of this transmitting force from one vertical wire to another. 1600 w. Elec Rev, Lond—April 14, 1899. No. 27-153 A.

Submarine.

The History of the Submarine Telegraph. A compilation giving the history of submarine telegraphy in chronological order. 3000 w. Elec Rev, N. Y.—April 26, 1899. No. 27311.

Telephony.

Improvements in Telephone Systems. Kempster B. Miller. Part first gives an illustrated description of a recent patent of G. K. Thompson for connecting lines of old and new systems, or with each other, without any special attention in the part of the operator. 1600 w. Elec Wld & Elec Engr—April 15, 1899. Serial. 1st part. No. 27052.

Telephones in Canada. An account of the service rendered by the Bell Telephone Co., which practically controls the business. 1000 w. U. S. Cons Repts, No. 403—April 8, 1899. No. 27090 D.

Telephones. John Gavey. A detailed account of telephones and telephone exchanges, especially the service in Great Britain. Also discussion. 6000 w. Jour Soc of Arts—April 14, 1899. No. 27180 A.

The Post-Office and Telephony. S. Alfred Varley. On the evil consequences of the policy adopted in England, in making telephony a Post-Office monopoly. 2400 w. Elec Rev, Lond—March 31, 1899. Serial. 1st part. No. 27001 A.

Testing Sets.

Inspectors' Portable Testing Sets. H. P. Clausen. Considers the requirements of a properly designed inspector's telephone test set and gives illustrated descriptions of commercial forms. 2500 w. Elec Engng—April, 1899. No. 27118.

ELECTRO-CHEMISTRY.

Alkali Works.

The Castner-Kellner Alkali Works at Weston Point. John B. C. Kershaw. An illustrated detailed description of the process, and introductory remarks concerning the slow progress of electrolytic processes in England. 3300 w. Elec Rev, Lond—March 31, 1899. No. 27000 A.

Batteries.

Relation Between the Heat Given Off Inside Voltaic Couples and the Heat Capable of Being Transmitted to the Circuit under the form of Chemical Energy. Dr. D. Tommasi. An explanation of investigations and results. 1300 w. Elec. Rev, Lond—April 7, 1899. No. 27074 A.

Diaphragms.

The Action of Membraneous Diaphragms in the Electrolysis of Salts. (Ueber das Verhalten von Membranen bei dem Elektrolytischen Transport von Salzen.) Dr. W. Bein. A very complete discussion of experiments with various membranes and solutions, forming an important contribution to the subject of electrical dialysis. 4000 w. Elektrochemische Zeitschr—April 1, 1899. No. 27268 F.

Electrodes.

Experiments with Carbon Electrodes. (Versuche mit Kohlenelektroden.) Dr. J. Zellner. A very full discussion of the advantages in the use of carbon electrodes in electrolytic processes, with tables of data for various solutions. 3000 w. Zeitschr f Elektrochemie—April 6, 1899. No. 27267 F.

Electrolysis.

Electrolysis in Battle Creek, Mich. W. W. Brigden. A description, with map, of the injury to water and gas pipes by electric currents wandering from a street railway. 900 w. Eng Rec—April 15, 1899. No. 27040.

Electro-Metallurgy.

Electrometallurgy. (L'Electrometallurgy.) P. Chalon. A review of the progress which has been made in winning and refining metals, comparing electrolytic and electrothermic methods. 3500 w. Rev

Univ des Mines—March, 1899. No. 27-252 G.

Galvanising.

Methods of Cold Galvanising. (Galvanisation à Froid.) M. Quivy. A study of the process of electro-chemical zincing of iron, with data as to baths, current, and operative details. 5000 w. Bull de la Soc d'Encour—March, 1899. No. 27-229 G.

ELECTRO-PHYSICS.

Accumulators.

Gas Electric Accumulators. (Leo Accumulateurs Electriques à Gaz.) A discussion of the improvements in gas storage batteries for electricity suggested by M. de Nansouty, showing the possibility of producing an accumulator of much less weight than has heretofore been possible. 2000 w. Revue Technique—March 25, 1899. No. 27216 D.

Alternating Currents.

Experiments on Alternate Current Arcs by Aid of Oseillographs. W. Duddell and E. W. Marchant. Abstract of a paper presented to the Inst. of Elec. Engs., London. Gives some of the more important results developed by the investigation. 3600 w. Elect'n, Lond—April 14, 1899. Serial. 1st part. No. 27149 A.

Galvanic Currents.

The Theory of Dissociation as Applied to Galvanic Currents. A von Oettingen. Deals with the phenomena attending electric currents in their entrance into, passage through, and exit from fluid electrolytes. 5800 w. Jour of Chem & Met Soc of S. Africa—Feb., 1899. No. 27146 E.

Induction Coils.

The Induction Coil Spark Analyzed. Describes the apparatus used, and investigations by Walter, which give light on this subject. Ill. 900 w. Elec Rev, Lond—April 7, 1899. No. 27076 A.

Interrupter.

Experiments with the Wehnelt Interrupter. George T. Hanchett. An account of recent experiments and results obtained by the writer. 1400 w. Elec Wld & Elec Engr—April 8, 1899. No. 26969.

Interrupting Devices for Induction Coils. (Unterbrechungsvorrichtungen für Induktionsapparate.) F. Dessauer. A general discussion of the subject, followed by a description of improved mechanically-operated mercury interrupters. 4000 w. Elektrotech Zeitschr—March 23, 1899. No. 27263 B.

The Wehnelt Electrolytic Interrupter. (Sur l'Interrupteur Electrolytique Wehnelt.) A. Blondel. A note to the French Academy reviewing the author's experiments, and discussing the action of the device. 1000 w. Comptes Rendus—April 4, 1899. No. 27246 D.

GENERATING STATIONS.

Accumulators.

Motor-Dynamos or Accumulators. Alton D. Adams. Showing the motor-generator often proves more desirable than the accumulator. 1800 w. St Ry Jour—April, 1898. No. 26922 D.

The Application of the Storage Battery. C. D. Wood. On the growing use and new applications. 2000 w. Yale Sci M—April, 1899. No. 27103 C.

Storage Batteries and Railway Power Stations. Robert McA. Lloyd. Points out some of the uses of a storage battery in connection with a typical station. Also discussions in New York and Chicago. 20800 w. Trans Am Inst of Elec Engs—Feb., 1899. No. 27101 D.

See Mechanical Engineering, Automobilism.

Alternators.

Running Alternators in Parallel. Describes a method patented by G. Dettmar, of Linden, near Hanover, which aims at the removal of the difficulty of separating two parallel-connected machines without affecting the terminal potential of the one which is to remain on the 'bus bars. 1500 w. Elec Eng, Lond. March 31, 1899. No. 26998 A.

Canal Plant.

The Electric Plant of the Bourgogne Canal. (Installation Electrique au Canal de Bourgogne.) M. Galliot. A general description of the hydraulic electric power plant utilizing the power of the Saone to supply the Bourgogne canal with water. 4000 w. 4 plates. Aun des Ponts et Chausseés—4 Trimestre 1898. No. 27-226 E + F.

Central Station.

The Electric Lighting of Lynton and Lynmouth. J. H. Fooks Bale. Illustrates and describes one of the most interesting stations in Great Britain. 2000 w. Elec Eng, Lond—April 7, 1899. No. 27071 A.

Dynamos.

American Practice in Dynamo Construction. B. A. Behrend in *Elektrotechniche Zeitchrift*. Brief comparison of American and European practice relative to the construction of electrical machinery. 1400 w. Elec Eng, Lond—March 31, 1899. No. 26999 A.

On a Direct Current Dynamo Without Brushes. Albert Campbell. Concludes that commutation can be obtained without slipping contacts, that is, in absolutely fixed circuits, by means of alterations in resistance produced by magnetic, thermal or other means. Ill. 1000 w. Elec Rev, Lond—April 14, 1899. No. 27151 A.

English Practice.

Central Station Practice in Great Britain. H. Cuthbert Hall. A critical review of British practice with especial reference to the principles governing the reduction of cost. 3500 w. Engineering Magazine—May, 1899. No. 27282 B.

High Pressure.

Electricity at High Pressures. Elihu Thomson's lecture before the New York Elec. Soc. Abstract. Considers methods of attaining high voltages and describes a novel adaptation of the Planté rheostatic machine for the production of high electrical pressures. 1000 w. Elec Rev, N. Y.—April 5, 1899. No. 26938.

Isolated Station.

Extensive Isolated Electric Station. Brief illustrated description of the electric lighting plant of the Philadelphia City Hall. 600 w. Elec Rev, N. Y.—April 19, 1899. No. 27095.

Operating Dynamos.

Accidents Due to Operating Dynamos in Multiple. An explanation of the serious trouble that may be caused under stated conditions. Ill. 1800 w. Power—April, 1899. No. 26858.

Regulator.

The Sayers Pressure Regulator with Third Brush. (Ueber die Sayers'sche Spannungsregulierung mittels Dritter Burste.) C. P. Feldman. An improved method of regulating voltage by the use of a third brush so arranged that its position relative to the main brushes may be shifted. The action is explained by numerous diagrams. 3500 w. Elektrotech Zeitschr—March 30, 1899. No. 27264 B.

Standards.

Standards for Direct Connected Generating Sets. J. B. Stanwood. Discusses the features that need standardization. 1500 w. Trans Am Soc of Mech Engs—May, 1899. No. 27302 D.

Transformer Losses.

The Effect of Alternating Current Wave-Forms on Transformer Losses. Louis Duncan, Ferd B. Keidel, William L. Hodges and Edmund Frank. Diagrams and report of investigations. 1100 w. Elec Rev, N. Y.—April 26, 1899. No. 27310.

LIGHTING.

Arc Lamps.

Triple-Connection System for 110 Volt Differential Arc Lamps. (Dreischaltungssytem bei 110 V Gleichstrom mit A. E. G. Differential bogen lampen.) J. Zeidler. A description of the new triple connection system of the Allgemeine Elektricitäts-Gesellschaft. 2500 w. Elektrotech Zeitschr—March 30, 1899. No. 27-266 B.

Arcs.

Arcs Produced by Non-Symmetrical Currents between Metals and Carbon. (Sur les Arcs à Courants Alternatifs Dissymétriques entre Métaux et Charbons.) A. Blondel. A communication to the French Academy discussing the peculiar nature of the arcs produced between metal and carbon points; with data and diagrams from numerous experiments. 2000 w. Comptes Rendus—March 20, 1899. No. 27243 D.

The Hissing of the Electric Arc. Mrs. Ayrton. Read before the British Inst. of Elec. Engs. An interesting and important record of investigations and results thus far reached. 8300 w. Elec Eng, Lond—March 31, 1899. Serial. 1st part. No. 26997 A.

California.

The Monterey and Pacific Grove Lighting Plant. Harry J. Bean. Illustrated description of this station as a type of the station most common throughout California. 1800 w. Jour of Elec—March, 1899. No. 27061.

Electric Plant.

See Marine Engineering.

Fountain.

The Illuminated Fountains at the Munich Exhibition. (Die Elektrische Leuchtfontaine auf der II Kraft-und Arbeitsmaschinen ausstellung in München.) F. Uppenborn. With illustrations showing the arrangement of the illuminating apparatus, and the shifting of the colored glasses. 1500 w. Elektrotech Zeitschr—March 23, 1899. No. 27262 B.

Leith.

The Electric Lighting of Leith. Illustrated general description of this installation. 1300 w. Elec Rev, Lond—April 14, 1899. No. 27154 A.

Nernst Lamp.

A One-and-One-Half Watt Lamp. Alton D. Adams. Considers the probable effect on arc and incandescent lamps, etc., if the claims of the Nernst lamp are sustained. 1000 w. Elec Wld & Elec Engr—April 1, 1899. No. 26890.

Street Lighting.

Electric Street Lighting. Albert Sheible. Read before the Chicago Elec. Assn. Reviews the causes that have affected street lighting in the past and recent changes due to electrical progress. 3500 w. Elec, N. Y—April 5, 1899. No. 26-932.

Suburban Residences.

The Lighting of Country Residences. Illustrated description of a number of

small lighting plants, with and without storage battery adjuncts, and a discussion of the essential features of such installation. 2000 w. Eng Rec—April 1, 1899. No. 26880.

MEASUREMENT.

Efficiency.

The Determination of the Efficiency of Continuous Current Dynamos. (Sur la Determination du Rendement des Dynamos à Courant Continu.) C. Pierron. A discussion of the various methods of measuring dynamo efficiency, with especial reference to that of Swinburne, with examples of its application. 2500 w. L'Electricien—April 8, 1899. No. 27,270 B.

Loads.

Effect of Inequality of Voltage in Three-Phase Wattmeters in Measuring Motor Loads. August J. Bowie. Reports of six tests made to determine to what extent the readings would be affected. 700 w. Elec Wld & Elec Eng—April 22, 1899. No. 27117.

Losses.

The Separation of Hysteresis, Foucault Current and Friction Losses in Electrical Machines. (Die Trennung von Hysteresis, Foucault-Strom, und Reibungsverlusten in Elektrischen Maschinen.) G. Dettmar. An elaborate discussion of the method of separating these losses, which must be measured together and subsequently analysed. Two articles. 6000 w. Elektrotech Zeitschr—March 16, 23, 1899. No. 27261, each B.

Measuring Instruments.

The Construction of a Voltmeter and Ammeter Suitable for a Small Switchboard. Nevil Monroe Hopkins. Directions for making simple forms of indicating instruments, and instruction for their calibration and care. Ill. 5700 w. Sci Am Sup—April 15, 1899. No. 27056.

Meter.

The Vulcan Electric Meter. (Compteur d'Energie Electrique, Type Vulcan.) M. Aliamet. An improved meter of the so-called "motor" type, consisting of a motor, a braking device, and a totaliser. 2500 w. L'Electricien—April 1, 1899. No. 27269 B.

POWER APPLICATIONS.

Coal Cutters.

See Mining and Metallurgy, Coal.

Electric Brakes.

See Mechanical Engineering, Automobilism.

Electric Power.

See Mining and Metallurgy, Mining.

Fan Motors.

Fan Motor Selection. Alton D. Adams. Discusses the relation between speed and capacity. Ill. 1800 w. Heat & Ven—April, 1899. Serial. 1st part. No. 27184.

Modern Plants.

The Electrical Transmission and Application of Power. Illustrates and describes three plants in the United States, each typical of a certain class of work, and of the industrial application by the same medium. 5500 w. Power—April, 1899. No. 26857.

Motive Power.

The Use of Electricity as a Motive Power in Modern Steel Works and Blast Furnaces. Andrew Ellicott Maccoun. Notes some of the uses to which motors are applied, and their advantages. 1100 w. Elec Wld & Elec Engr—April 15, 1899. No. 27051.

Polyphase.

Electric Driving with Polyphase Currents. (Elektrischer Einzelantrieb mit Drehstrom.) O. Lasche. With especial reference to the application of polyphase currents to the independent driving of machine tools as installed at the Allgemeine Elektricitäts Gesellschaft in Berlin; very fullv illustrated. 5000 w. Zeitschr d Ver Deutscher Ing—March 18, 1899. No. 27201 D.

Polyphase Motors of Great Starting Movement and Capacity. (Ueber Drehstrommotoren mit Grossem Anzugsmomente und Grosser Beanspruchungsfähigkeit.) T. Marcher. A mathematical analysis of the conditions involved, and graphical representations, giving curves for the various elements. 4500 w. Elektrotech Zeitschr—March 30, 1899. No. 27265 B.

Three-Phase.

See Street and Electric Tramways.

MISCELLANY.

Cost of Electricity.

Data on Electric Power Generation, Glasgow. Reviews a report by H. F. Parshall on the expense of generating current for the Glasgow street railways; a single central station with three phase distribution to transformer stations is recommended. 1300 w. Eng Rec—April 22, 1899. No. 27136.

Electrolysis.

The Problem of Electrolysis. An editorial on the importance of fixing the responsibility of repairs to water mains which are injured by electric currents from street railways. 1600 w. Eng Rec—April 22, 1899. No. 27127.

GAS ENGINEERING

Acetylene.

Acetylene and its Applications. (L'Acétyléne et ses Applications.) M. E. Hubon. An extended review of the present status of lighting by acetylene, including descriptions of generators, burners and other appliances. 10,000 w. Soc Ing Civ de France—Feb., 1899. No. 27237 G.

Calcium Carbide and Acetylene. Part first reviews the history of the manufacture of calcium carbide. 1600 w. Ind & Ir—April 14, 1899. Serial. 1st part. No. 27148 A.

The Explosiveness of Acetylene when Mixed with Inert Gases. (Sur l'Aptitude de l'Acétylène Mélange à des Gaz Inertes.) MM. Berthelot and Vieille. A very full account of the further researches of these distinguished investigators, showing the influence of the composition of the diluting gas. An important paper. 4000 w. Comptes Rendus—March 27, 1899. No. 27244 D.

The Fire Underwriters' Rules for Safe Introduction of Acetylene Gas Generators. Charles A. Hexamer. A copy of the rules, with introductory remarks. 1800 w. Jour Fr Inst—April, 1899. No. 26953 D.

The Real Value of Acetylene as an Illuminant. Gives a comparison of different illuminants as regards cost, illuminating power, and hygienic effect. 3300 w. Engr, Lond—March 31, 1899. No. 26971 A.

Distribution.

Distribution Records; Their Uses and Preservation. J. A. Mayers. Read before the Ohio Gas Lgt. Assn. Describes methods of keeping records. 5700 w. Am Gas Lgt Jour—April 3, 1899. No. 26905.

Edinburgh.

New Gas Works at Edinburgh. A review of Mr. Herring's report and the main features of construction as recommended for the new works which will replace a number of old establishments. 4400 w. Engr, Lond—March 24, 1899. No. 26872 A.

Forms.

Some Forms and Their Uses. Walton Forstall. Forms from various sources for the preservation of information connected with the gas industry. 4000 w. Am Gas Lgt Jour—April 24, 1899. No. 27140.

Fuel Gas.

Industrial Gas. Frank H. Bates. Part first considers methods of gas analysis. 6000 w. Jour of Elec—April, 1899. Serial. 1st part. No. 27179.

The Riché Generator of Gas from Wood. (Le Gazogène au Bois "Riché.") MM. Manant and Roman. A very full account of the Riché process, with sections and details of generators, and a discussion of its industrial applications. 10,000 w. Soc Ing Civ de France—Feb., 1899. No. 27239 G.

Gas Exhausters.

Gas Exhausters and Gas Exhausting Plant. R. Hargraves. Abstract of paper read at meeting of the Manchester, Eng., Assn. of Engineers. Reviews the introduction and development of exhausters, the engines usually used for driving, and shows that the best plant for exhausting coal gas was far behind the present practice. Discussion. 4000 w. Jour Gas Lgt—March 28, 1899. No. 26983 A.

Hydrocarbons.

The Condensable Hydrocarbons in Coal Gas. Wilfrid Irwin. Read before the Manchester Section of the Soc. of Chem. Ind. Considers the effect of high temperatures, vapor tensions, and the superiority of benzine for enrichment. 1800 w. Gas Wld—March 25, 1899. No. 26869 A.

Incandescence.

Experiences with the Incandescent Gas Light. Norton H. Humphreys. On the value of this invention to the gas industry and the general public, and some of the reasons why it has not been more cordially welcomed are considered in the present number. 2800 w. Jour Gas Lgt—April 4, 1899. Serial. 1st part. No. 27054 A.

Inclined Retorts.

An Experience with Inclined Retorts, Esslingen, Germany. Ernest Kohler. Translated from the *Journal fur Gasbeleuchtung*. An account of the benches of inclined retorts erected in 1897. 1500 w. Am Gas Lgt Jour—April 17, 1899. No. 27063.

Street Lighting.

Welsbach Street Lighting. J. W. R. Cline. Read at meeting of the Ohio Gas Light Assn. Calls attention to some of the difficulties met, and the manner in which they were overcome, noting features of interest in the apparatus. Discussion. 7000 w. Am Gas Lgt Jour—April 10, 1899. No. 26984.

Welsbach.

The Rawson Patents Sustained. The decision of Judge Shipman in the case of the Welsbach Light Co. vs. Apollo Incandescent Light Co. et al. 2300 w. Pro Age—April 15, 1899. No. 27031.

MARINE AND NAVAL ENGINEERING

Amphitrite.

The Steam Trials of H. M. S. "Amphitrite." This article was written when only one trial had been completed, the 3600 indicated horse-power trial which is reported very satisfactory. 1300 w. Engng—April 14, 1899. No. 27164 A.

Ballasting.

The Ballasting of Steamers. Editorial discussion of this subject and the need that something be done to remedy the trouble and lessen the casualties due to this cause. 1700 w. Engr, Lond—March 24, 1899. No. 26874 A.

British Shipping.

British Shipping and Ship-building. The large business in ship-building in British yards during the past year and the promise of increase the coming year, and matters of special interest in connection with the mercantile marine. 2800 w. U. S. Con Repts, No. 402—April 17, 1899. No. 27064 D.

Cable Ship.

The United States Cable Ship "Hooker." Brief description, with illustration, of the ship that will lay cables between the Philippine Islands. 700 w. Elec Rev, N. Y.—April 26, 1899. No. 27309.

Construction.

The Means and Aim of Marine Construction in Germany at the Beginning of the Twentieth Century. (Ueber Mittel und Ziele des Deutschen Wasserbaues am Beginn des XX Jahrhundert.) J. F. Bubendy. A review of marine construction up to the present time, including harbours, channels, docks, canals, etc., and a discussion of future needs in view of the increasing size of vessels. Three articles. 6000 w. Deutsche Banzeitung—March 25, 31, April 5, 1899. No. 27272, each B.

Cruiser.

A Model Cruiser. Illustrates and describes the Tigress model cruiser, constructed by Charles L. Palmer, Albany, N. Y. 1300 w. Engr, Lond—April 14, 1899. No. 27172 A.

H. M. S. Spartiate. Illustrated description, with drawings of the engines and boilers. 1800 w. Engr, Lond—April 7, 1899. No. 27085 A.

The Japanese Protected Cruiser Kasagi. Illustrated description of the vessel and her armament. 1800 w. Engr, Lond—March 31, 1899. No. 26973 A.

Disasters.

Marine Breakdowns and Losses. A narrative of the mishaps which befell some well-known liners. 2000 w. Marine Engng—April, 1899. No. 26888 C.

Dock.

Great Floating Dock. Plans and information concerning a structure recently contracted for by the United States, which will be the largest floating dock in the world. 800 w. Marine Rev—April 20, 1899. No. 27143.

Efficiency.

Efficiency of the Twin-Screw Steam Yacht Sovereign. John D. Hackstaff, Warren H. Miller, Waldo G. Lunger. Graduating thesis discussing the application of Rankine's Theory of the Mathematical Action of Screw Propellers in determining the efficiency of this yacht and of distribution and dissipation of the power given out by her engines. 1500 w. Stevens Ind—April, 1899. Serial, 1st part. No. 27124 D.

Electric Plant.

Electricity on American Vessels. J. McGhie. Part first gives an illustrated description of the equipment of the "Priscilla," a passenger and freight steamer plying on Long Island Sound. 1300 w. Elec Eng, Lond—April 7, 1899. Serial. 1st part. No. 27072 A.

French Steamer.

The French Passenger Steamer "Laos." An account of the Compagnie des Messageries Maritimes, with description of this new high-class vessel. Ill. 1700 w. Engng—March 31, 1899. Serial. 1st part. No. 26981 A.

Ice Breaking Steamer.

The Ice-Breaking Steamer "Ermack." Information respecting this interesting vessel built for the Russian government. Ill. 4200 w. Engng—March 31, 1899. No. 26980 A.

Lake Steamer.

Saloon Steamboat "Genève," on the Lake of Geneva. (Das Salonboot "Genève." auf dem Genfer see.) An illustrated description of this fine new Swiss lake steamer, built by Sulzer Bros., of Winterthur. 1000 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 1, 1899. No. 27206 D.

Mercantile Marine.

The French Marine. Editorial discussion of the new strategy of the Minister of the Marine, and of the debate on the estimates in the Chamber of Deputies. 3000 w. Engr, Lond—March 31, 1899. No. 26975 A.

Naval Boilers.

See Mechanical Engineering, Steam Engineering.

Navies.

The Naval Situation. H. W. Wilson. Discusses the position of the seven great Powers, the growth of navies, new factors in naval war, and the standing of Great Britain. 7000 w. Nineteenth Cent—April, 1899. No. 27091 D.

Oil.

The Action of Oil on Waves at Sea. Notes on the calming action of oil in rough weather. 1200 w. Engr, Lond—April 14, 1899. No. 27171 A.

Repair Ship.

The Work of the U. S. S. Vulcan. Facts given by William S. Aldrich in a lecture before the junior members of the A. S. M. E. on March 7, relative to the work while the ship was with Sampson's fleet. 2000 w. Mach, N. Y.—April, 1899. No. 26845.

Resistance.

The Resistance of Transverse Waves to the Progress of Vessels. (De la Résistance à l'Avancement des Bateaux et des Ondes Transversales.) M. F. Chandy. A mathematical discussion in connection with models for use in tank trials, showing the influence of the dimensions of the tank upon the results. 3500 w. Soc Ing Civ de France—Feb., 1899. No. 27236 G.

Riveters.

See Mechanical Engineering, Machine Works.

Shafts.

See Mechanical Engineering, Machine Works.

Ship Yard.

A Great Ship Yard. Full illustrated description of the many departments of the Newport News yard, with brief account of the founder, and of its rapid development. 12000 w. Marine Rev—March 30, 1899. No. 26856.

Stability.

Calculating Cross-Curves of Stability. C. F. Munday. Read before the Inst. of Naval Archts. On the advantages of using Tchebycheff's rule in association with the integrator to obtain cross-curves of stability. 1200 w. Engng—April 14, 1899. No. 27167 A.

Steering.

An Account of the Attempts to Introduce Compressed Air for Steering Vessels. J. C. Walcott. Gives the history of attempts in this line during the last fifteen years, stating the benefits, and the improvements. 700 w. Compressed Air—April, 1899. No. 26987.

Stresses.

Stresses on Ships. J. Bruhn. Paper read before the Inst. of Naval Archt's, England, on the "Stresses at the Discontinuities in a Ship's Structure." Deals with the forces acting on the vessel as a whole, and not with those due to local forces. 6000 w. Engng—March 31, 1899. No. 26982 A.

Submarine Boats.

French Submarine Torpedo Boats. Illustrates and describes the vessels built by Gustave Zédé, and their trials. 1800 w. Sci Am—April 8, 1899. No. 26933.

Submarine Mines.

Electric Fuses and Exploders for Submarine Mines. J. Wright. Describes the principal fuses and exploders employed in the submarine mines of the American navy during the last few years, with their behavior under trial. 2500 w. Ind & East Engr—March, 1899. Serial. 1st part. No. 27158 D.

Tank Steamer.

S. S. Atlas, New Oil Tank Steamer for the Standard Oil Co. Plans, photograph and description. 1600 w. Marine Engng—April, 1899. No. 26887 C.

Tow Boats.

The Tow-Boats "Infatigable" and "Taillebourg." (Les Remorqueurs "Infatigable" et "Taillebourg.") A full description of two powerful tow-boats recently acquired by the French government from Holland, with photographs and a plate of engine details. 2500 w. 1 plate. Génie Civil—April 8, 1899. No. 27214 D.

Trials.

Some Steam Trials of Danish Ships. A. Rasmussen. Read before the British Inst. of Nav. Engs. Report of trials made to determine the elements of propulsion of ships and torpedo boats under various circumstances. 1600 w. Engng.—March 24, 1899. No. 26868 A.

Tug.

Most Powerful Tug. Illustration with description of the new towing steamer, R. W. Wilmot, which exeeeds in engine capacity any other similar craft in American waters. 1400 w. Marine Rev—April 20, 1899. No. 27142.

Warships.

The Logical Arrangement of the Motive Power of Warships. George W. Melville. Points out some of the advantages due to the use of three propelling engines as shown in the U. S. cruisers Columbia and Minneapolis, and the methods of arrangement as thus far investigated. Also considers the disadvantages. 5500 w. Engr, Lond—March 24, 1899. Serial. 1st part. No. 26873 A.

The Monitor, the Battleship, the Cruiser, and the Destroyer. G. W. Dickie.

Mr. Dickie's concluding paper discusses the function of the cruiser, and gives a very careful analysis of the qualities necessary for an efficient destroyer, with a design for a proposed sea-going torpedo boat destroyer. 3000 w. Engineering Magazine—May, 1899. No. 27280 B.

Yachts.

Steam Power of Small Yachts. William Burlingham. Rules for calculating the displacement, horse-power, speed and the necessary points about the propeller for small boats of medium speed. 2000 w. Mach, N. Y.—April, 1899 No. 26846.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

The Crowdus Accumulator. Illustrates and describes a cell which has been claimed to be the most suitable yet designed for automobile purposes. 1500 w. Automotor Jour—April, 1899. No. 27324 A.

Differential Gear.

The De Dion and Bouton Differential Gear. Reviews what is known of this invention and gives illustrated description of the gear named which is claimed to be the best form of differential yet devised. 1000 w. Automotor Jour—April, 1899. No. 27321 A.

Electric Brakes.

An Independent Motor to Utilize the Brake Energy. Merrill E. Clark. Abstract of a lecture describing a system of independent motor and a means of utilizing the brake energy in connection with street railways and other traction. Ill. 700 w. Compressed Air—April, 1899 No. 26986.

The Value of Electric Brakes as Recuperating Devices for Automobiles. F. B. Booth. Considers that the value rests wholly with the conditions under which the vehicle is used, and that it is not likely to be used on vehicles built for city service. 1400 w. Elec Wld & Elec Engr—April 8, 1899. No. 26968.

French Law.

The Law Relating to Motor Vehicles in France. Rules for traffic on the public roads with editorial. 3000 w. Automotor Jour—April, 1899. No. 27327 A.

Motor Carriages.

Joel Electric Motor Carriage. Illustrates and describes a new form of motor carriage said to run very smoothly with little vibration. 1700 w. Elec Rev, Lond—April 7, 1899. No. 27075 A.

Motor Carriages and Street Paving. Thomas Conyngton. On the progress and outlook for these vehicles and the effect on the life in cities that would result from their general use. 1700 w. Munic Engng—April, 1899. No. 26893 C.

Steam Driven Road Carriages. William H. Harrison. Describes a proposed construction of a steam carriage weighing about 1500 pounds with riders. 2200 w. Am Mach—April 6, 1899. No. 26942.

Moto-Wheel.

The Simms Patent "Motor Wheel." Illustrated detailed description. 900 w. Automotor Jour—April, 1899. No. 27323 A.

Omnibus.

The Serpollet Steam Omnibus. Illustrates and describes a vehicle built to accommodate 14 passengers, and carry 1100 lbs. of baggage. 600 w. Automotor Jour—April, 1899. No. 27325 A.

Tricycle.

Automobile Tricycle with Variable Speed Gear. (Tricycle Automobile à Vitesse Variable.) Ch. Gruet. Describing a practical form of variable gear to be used in connection with a petroleum motor, enabling a smaller motor to be used, and permitting low gears to be obtained for ascending grades. 2000 w. Revue Technique—April 10, 1899. No. 27220 D.

Tyres.

General Notes Respecting India Rubber Tyres for Carriages and Moto-Vehicles. Illustrates and describes the chief existing types of tyres, gives suggestions relating to the choice of tyres, and advice as to their maintenance and preservation. 2400 w. Automotor Jour—April, 1899. No. 27326 A.

Rolling Resistance to India Rubber Tyres. H. E. Wimperis. The present article deals with the elasticity of the air in pneumatic tyres, and discusses how far it is perfect or imperfect. 900 w. Automotor Jour—April, 1899. Serial. 1st part. No. 27322 A.

The General Relation of Tires to Motor Vehicle Construction. Considers the relation of the parts, and the effect on the wear of tires. 1000 w. Horseless Age—April 5, 1899. No. 26931.

See also Materials.

Vehicle Motors.

Some Thermo-Dynamics of Vehicle Motors. Hudson Maxim. Data on relative efficiencies of various motor fluids in their application to vehicle propulsion.

7300 w. Horseless Age—April 5, 1899 No. 26930.

HYDRAULICS.

Deep Wells.

Experiences with Deep-Well Pump Rods. G. W. Bissell. Describes experiences in connection with the deep well which constitutes the principal water supply of the Iowa State College. 1000 w. Trans Am Soc of Mech Engs—May, 1899. No. 27194 D.

Fire Hydrants.

Experiments on Various Types of Fire Hydrants. Charles L. Newcomb. A report of tests aiming to make a complete investigation of the fire hydrants now commonly used, giving tabulated results. Ill. 15000 w. Trans Am Soc of Mech Engs—May, 1899. No. 27190 D.

Power Distribution.

Hydraulic Transmission and Distribution of Power. E. B. Ellington. The first portion of a presentation of the claims of high-pressure hydraulic transmission to consideration, being devoted to questions of the cost of generation and transmission, and to be followed by details of application. 3000 w. Engineering Magazine—May, 1899. No. 27284 B.

Pumps.

A Gasoline Pumping Plant for the Water-Works of Toms River, N. J. Information concerning this installation. Ill. 700 w. Eng News—March 30, 1899. No. 26861.

An Air-Chamber Charging Pump. Walter Ferris. On the operation, uses and usefulness of the air-pump. Ill. 1200 w. Am Mach—March 30, 1899. No. 26852.

Repairing a Deep-Well Pump. Describes a mishap that occurred in lowering a pump and the means taken to set matters right. 1700 w. Engr, Lond—March 31, 1899. No. 26979 A.

Propeller Pumps. Describes an apparatus for raising water in wells by means of horizontal wheels working like the propellers of a steamship. 1000 w. Eng Rec—April 22, 1899. No. 27131.

MACHINE WORKS AND FOUNDRIES.

Boring Cylinders.

Boring Cylinders for Motor Vehicles. Robert I. Clegg. Considers tools, expedients and methods used. 1600 w. Horseless Age—April 12, 1899. No. 27016.

Car Wheels.

The Manufacture of Car Wheels. G. R. Henderson. Points about the manufacture of car wheels which have been observed by the writer. The lessons learned from chemical analysis and physical tests. 3500 w. Trans Am Soc of Mech Engs—May, 1899. No. 27187 D.

Casting.

Casting a Power-Press Frame. R. H. Palmer. Sketches, with description of a casting weighing some 4,000 lbs. 1500 w. Foundry—April, 1899. No. 27120.

Chemistry.

Dividing the Authority. E. C. Wheeler. On a chemist's position in a foundry. 1800 w. Foundry—April, 1899. No. 27121.

Dies.

Die Construction. George B. Painter. Description and drawing showing a construction useful in duplicating shapes. 1500 w. Am Mach—April 6, 1899. No. 26941.

Drafting.

Drafting Methods of the Newport News Shipbuilding & Dry-Dock Co. An account of the methods adopted in carrying on the designing and estimating work. 1500 w. Eng Rec—April 15, 1899. No. 27035.

Elevators.

Elevators. Charles R. Pratt. Considers the requirements of an elevator, and describes the means used to meet them. Ill. 15,900 w. Trans Am Soc of Mech Engs—May, 1899. No. 27191 D.

The Plunger Elevator. George J. Alden. Illustrates and describes this elevator and presents its merits as an appliance for modern office buildings. 5500 w. Trans Am Soc of Mech Engs—May, 1899. No. 27186 D.

Fall of an Elevator in Chicago. An account of the accident, and substance of the inspector's report of the investigation. 500 w. Eng News—April 27, 1899. No. 27340.

The Elevator Equipment of the Ivins Syndicate Building, Park Row, New York. Describes the solution of the problem of furnishing rapid and safe transit to and from the various floors of the highest office building in the world. Also editorial comparison of electric and hydraulic elevators for high buildings. Ill. 5800 w. Eng News—April 27, 1899. No. 27341.

Flanges.

Experiments on Flange Joints. (Versuche mit Flanschenverbindungen.) C. Bach. A very fully illustrated account of tests made upon the strength of bolted flange-joints on pipes, valves, etc. Accurate measurements of the deformation under various pressures were made, and much valuable information deduced. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—March 25, April 1, 1899. No. 27204 each D.

Pipe Flanges and Their Bolts. A. F. Nagle. Analyzes the forces at work upon a flange joint and recommends changes that aim to relieve the material of strains. 2000 w. Trans Am Soc of Mech Engs—May, 1899. No. 27188 D.

Fly-Wheels.

Rolling Mill Fly-Wheels. John Fritz. A review of the progress made in the construction of fly-wheels. Ill. 1500 w. Trans Am Soc of Mech Engs—May, 1899. No. 27196 D.

Foundry.

New Foundry of the General Electric Co. Illustrated description of the building known as "No. 83," of the Schenectady plant. 1800 w. Ir Age—April 6, 1899. No. 26936.

The New Foundry of the General Electric Co. Illustrated description of an iron foundry measuring 505 x 140 ft., with a 120 x 103 ft. wing. Explains the construction of oven doors swinging on ball-bearings, and core carriages having pneumatic movement and automatic doors. 1200 w. Eng Rec—April 15, 1899. No. 27038.

Foundry Heating.

Heating the Foundry of the General Electric Co. An illustrated account of the plant for heating this new building. 1400 w. Ir Age—April 27, 1899. No. 27314.

Gears.

A New System of Bevel Gear Making. Illustrates and describes some late machines designed by O. J. Beale, of the Brown & Sharpe Manufacturing Co. 1100 w. Am Mach—April 6, 1899. No. 26939.

Lathes.

A Large Pattern Lathe. John Randol. Illustrates and describes a heavy pattern lathe at the iron works of Struthers, Wells & Co., Warren, Pa. 1300 w. Am Mach—March 30, 1899. No. 26853.

Machine Construction.

The Present Status of Machine Construction. (Ueber die Heutige Bedeutung des Maschinenbaues.) P. Zwianer. An address delivered at the fiftieth anniversary of the Austrian Society of Engineers, reviewing the development of mechanical engineering in Europe during the latter half of the century. 5000 w. Zeitschr d Oesten Ing u Arch Ver—April 7, 1899. No. 27209 B.

Molding.

Making a Roller Path in Loam. James A. Murphy. Illustrated description of the making of a large casting. 1900 w. Foundry—April, 1899. No. 27119.

Molding a Wheel Segment. R. H. Palmer. Illustrated description of the molding of a segment of a driving-wheel of a large Corliss engine. 2200 w. Am Mach—April 27, 1899. No. 27317.

Ornamental Iron.

The Use, Design and Manufacture of Iron in Ornament. Chester B. Albree. Abstract of a paper read at the monthly meeting of the Engs. Soc. of W. Penna. Discusses the ancient and modern work and the need of a better understanding on the part of architects and designers of the processes of manufacture. 900 w. Ir Trd Rev—March 30, 1899. No. 26842.

Preston Works.

New Electric Tramcar and Railway Carriage Works at Preston. A description of the various departments in the order in which they receive the materials. 1700 w. Engr, Lond—March 31, 1899. No. 26977 A.

Repair Shops.

Power Station and Repair Shops of the Cleveland Electric Railway Co. Illustrated detailed description of a plant having many interesting features. 4000 w. St Ry Jour—April, 1899. No. 26919 D.

Rifles.

Manufacture of Krag-Jorgensen Rifles at the Springfield Armory. Part first gives an illustrated description of the famous Springfield Armory in which all types of small arms for the United States have been made since the Revolution. 2300 w. Sci Am—April 29, 1899. Serial. 1st part. No. 27319.

Riveters.

Portable Pneumatic Riveters in Shipbuilding. W. J. Babcock. Read at meeting of the Inst. of Naval Archts. Describes methods used in the yards of the Chicago Shipbuilding Co. 3000 w. Engr, Lond—March 31, 1899. No. 26978 A.

Screw-Threads.

The Unification of Screw Threads. (Unification des Filetages.) The full report of the International Congress at Zurich for the unification of metric screw-thread systems, with the text of the discussions, and a bibliography of the subject. 10,000 w. Bull de la Soc d'Encour—March, 1899. No. 27231 G.

Shafts.

Another Diagram for the Design of Shafts. C. L. Griffin. Diagram with explanation of its use. 500 w. Am Mach—April 6, 1899. No. 26940.

Notes on the Manufacture of Shafting for Screw Steamers with Some Causes of Defects and Failures. Edward Catmore Chaston. Abstract of a paper read before the North-East Coast Inst. of Engs. and Shipbuilders, with editorial comment. The writer aims to show that about half of the defects and failures are due to preventable causes. 4800 w. Engs Gaz—April, 1899. No. 26993 A.

Remarks on the Increasing Frequency of Failure of Propeller Shafts. Frank Caws. Read before the North-East Coast Inst. of Engs. and Shipbuilders. Alludes to the possibility of adopting larger and hollow shafting, and shows that rules for the diameter of a steamer's shafting should not be based only on the power of the engines, but also on the power of the ship's displacement at the light draught. 2700 w. Ind & Ir—March 30, 1899. No. 27002 A.

Speed Diagram.

A Pulley Speed-Ratio Diagram. Gives a diagram and method of using, of service in all problems relating to the diameter and speed of wheels, rims, pulleys, etc. 150 w. Mech Wld—April 7, 1899. No. 27067 A.

Tools.

English and American Machine Tools. T. Wood Meakin. Points in which, in the opinion of an English engineer, American tools might be better adapted to the needs of English shops. 2400 w. Mod Mach—April, 1899. No. 26895.

Machine Tools. J. Richards. Part first consists of general remarks introductory to a review and criticism of the practice. 2200 w. Am Mach—April 27, 1899. No. 27316.

Modern Turret Lathes and Screw Machines. Joseph Shepherd. Abstract of a paper and interesting discussion presented at meeting of Glasgow Assn. of Students of the Inst. of Civ. Engs. Deals considerably with the superiority of foreign made tools, describing some of them, and showing the great saving by their use. 5000 w. Engr, Lond—March 24, 1899. No. 26875 A.

Some Amateurs' Machine Tools in England. F. J. M. Illustrates and describes tools built for the use of amateur mechanics by the firm of G. Birch & Co., England. 2100 w. Am Mach—April 27, 1899. No. 27315.

Transport.

Means of Transport in and About Works. Jenner G. Marshall. From a paper read before the South Staffordshire Inst. of Iron & Steel Works Managers. Considers fixed means, including canal and dock basins, railways, cranes, elevators, conveyors, capstans and rope-haulage; and movable, including carts, trolleys, sliding skids, ways and rollers, traction engines, etc. 3300 w. Col Guard—March 30, 1899. No. 27005 A.

Westinghouse.

The Westinghouse Electric Works at Pittsburg. An illustrated detailed description. 2500 w. Engng—March 24, 1899. Serial. 1st part. No. 26866 A.

Wood-Working Machinery.

The Development of Woodworking Machinery. John Richards. Devoted to a comparison between English and American wood planing machines with many handsome illustrations of characteristic types. 3500 w. Engineering Magazine—May, 1899. No. 27286 B.

Works Management.

Machine Shop Management in Europe and America. H. F. L. Orcutt. The fifth paper of the series is devoted to the growth of competition and its influence upon the development of trade, showing the action of national characteristics and methods. 3500 w. Engineering Magazine—May, 1899. No. 27287 B.

MATERIALS OF CONSTRUCTION.

See also Civil Engineering, Materials.

Elastic Limit.

The Elastic Limit and Yield Point of Steel. Explains the difference between the elastic limit and the yield point in making tensile tests, and shows the importance of an accurate determination. 1000 w. Prac Engr—April, 14, 1899. No. 27145 A.

Erosion.

The Erosion of the Bore of Artillery. (L'Erosion de l'Interieur des Canons.) A discussion of the probable causes of bore-erosion, taking into account the physical constitution of the steel as revealed by metallography. 1200 w. Revue Technique—April 10, 1899. No. 27219 D.

Gun Explosion.

Cause of the Recent Explosion of the Ten-Inch Gun at Sandy Hook Explained. Hudson Maxim. An explanation by one of the inventors of the smokeless powder used. Ill. 2000 w. Sci Am—April 8, 1899. No. 26934.

Explosion of a Gun at Sandy Hook, New York Harbor. Discusses the cause of the accident. 1500 w. Engng—April 14, 1899. No. 27165 A.

Metallography.

Microscopic Studies upon Deeply-Etched Sections of Iron. (Mikroskopische Untersuchungen au Tiefgeätzten Eisenschlissen.) E. Heyn. An important contribution to the study of the physical character of iron, with photogravure reproductions of many deeply etched sections. 7500 w. 6 plates. Mitt aus den Kgl Tech Versuchaustalt—Part VI, 1898. No. 27257 G.

Springs.

Safe Loads for Helical Springs. Robert A. Bruce. The discussion considers the cylindrical helical spring. Ill. 2000 w. Am Mach—April 20, 1899. Serial. 1st part. No. 27096.

Steel.

See Mining and Metallurgy, Iron & Steel.

Stresses.

Repeated Stresses. Jerome Sondericker. Also discussion by James E. Howard. Presents tests and gives a general discussion of the results obtained up to date. Investigations are given for the determination of the elastic changes resulting from the repeated stresses, and the influence of such changes in causing fracture; and the influence of form, flaws, and the local condition generally in causing fracture. Ill. 6000 w. Tech Quar—March, 1899. No. 27020 E.

Tests.

Second Series of A. F. A. Tests. Gives the results of transverse, tensile and compression tests of bars. 1000 w. Ir Trd Rev.—April 13, 1899. No. 27033.

Tyres.

India-Rubber Carriage Tyres. Editorial discussing the growing use of these tyres, the cost, quality of rubber, and points connected with the raw material. 2200 w. Engng—April 7, 1899. No. 27077 A.

POWER AND TRANSMISSION.

Belts.

Relation Between the Initial Tension and Power Transmitted by a Belt. F. L. Emory. Formula for finding the initial tension on a belt when still, in order to transmit or develop a certain work when running, with graphical illustrations. 500 w. Trans Am Soc of Mech Engs—May, 1899. No. 27193 D.

Rules for Determining the Horse-Power of Belts. Abstract of a paper read by John J. Flather before the North-West Ry. Club. A practical discussion of the belting problem, with rules and tables for making all necessary calculations. 2500 w. Mach, N. Y.—April, 1899. No. 26847.

Compressed Air.

Air Compression. Robert Peele. Illustrates and describes the structure and mode of action of the five classes commonly used. 2400 w. Mines & Min—April, 1899. No. 26918 C.

Compressed Air Enterprises. George C. Densmore, in *Municipal and Railway Record*. Reviews various applications especially as a motive power for railway traction, noting the undertaking on the 28th and 29th street railway in New York. 2500 w. Compressed Air—April, 1899. No. 26988.

Compressed Air Motors in Boston. Gives Mayor Quincy's views on the use of compressed air for a motive power, and states some advantages of liquid fuel over compressed air. 1700 w. Bos Jour of Com—April 1, 1899. No. 26909.

Compressing Air to Produce a Dry Atmosphere. Frank Richards. In response to an inquiry where dry air is needed in the manufacture of a chemical, the writer explains how to obtain such an atmosphere. 1300 w. Am Mach—April 20, 1899. No. 27097.

Economy of Compressed Air Power Transmission. William O. Webber. Considers the possibilities of this method of storing and converting energy. 1200 w. Am Mach—April 13, 1899. No. 27010.

Pneumatic Equipment for Boiler Shops. E. A. Rix, in the *Boiler Maker*. On the numerous applications of pneumatic tools to work in these shops, and the economy secured by their use. 2000 w. Ir Trd Rev—April 20, 1899. No. 27106.

Pneumatic Tube Delivery System at the Waldorf-Astoria Hotel. Illustrated description of a system handling often 10,000 letters, cards, etc., a day, which has never had a breakdown during the eighteen months it has been in operation. 1200 w. Sci Am—April 15, 1899. No. 27014.

The Pneumatic Mail Tube System. J. Foster Symes. Gives the history of the progress of this system in different countries, describing the New York system for the transmission of mail. 2100 w. Yale Sci M—April, 1899. No. 27105 C.

Fuel Gas.

See Gas Engineering.

Office Building.

See Architectural Engineering, Construction.

Power Cost.

The cost of the Generation of Power. (Kosten der Krafterzengung.) N. Holz. A supplement to Eberle's recent work on the same subject, with diagrams showing the cost of power generated by a variety of heat motors, as compared with water power. 2500 w. Zeitschr d Ver Deutscher Ing—March 18, 1899. No. 27202 D.

Power Multiplying.

Two Power Multiplying Engines. An account of an engine recently on exhibition at the Liberty Bldg., New York; also of another being exploited in Philadelphia, showing the absurdity of the claims. 3500 w. Eng News—April 6, 1899. No. 26946.

Power Plant.

A Factory Power Plant. Description of a Newark, N. J., plant which is entirely independent of outside companies or the municipality for its water supply, electricity, fire protection and power. 1400 w. Eng Rec—April 8, 1899. No. 26964.

The Power Plant of a University. Edward A. Darling. Describes the design and installation of the plant, showing in

outline the building equipment it serves, and its operation. Ill. 15500 w. Trans Am Soc of Mech Engs—May, 1899. No. 27199 D.

Steering.

See Marine and Naval Engineering.

SPECIAL MOTORS.

Gas Engines.

A Gas Engine Drive in a Machine Shop. A. R. Bellamy. Extract from a paper read before the Manchester, (Eng.) Assn. of Engs. An account of the installation and cost of operation of a plant. 2300 w. Am Mach—April 13, 1899. No. 27011.

Double Acting Gas Engine. (Moteur à Gaz à Double Effet.) An illustrated description of the Letombe gas engine in which the regulation is effected by a variable compression controlled by the governor. Indicator diagrams, and a plate of working details are given. 2000 w. 1 plate. Génie Civil—April 1, 1899. No. 27213 D.

Investigations of Gas Engines, with Especial Reference to the Influence of the Compression. (Untersuchungen am Gasmotor, insbesondere über den Einfluss der Kompression.) E. Meyer. A mathematical discussion of data obtained from numerous tests, with numerous diagrams, made at the Technical High School at Hanover. Three articles, 10000 w. Zeischr d Ver Deutscher Ing—March 18, 25, April 1, 1899. No. 27200 each D.

Gas and Gasoline Engines. The first of a series of articles aiming to give accurate information as to the use of such engines. Part first deals with heat as shown in the changing of volumes of gases. 2000 w. Am Mfr & Ir Wld—April 21, 1899. Serial. 1st part. No. 27141.

Gas Engines. J. Emerson Dowson. Abstract of a paper read before the Cleveland Inst. of Engs., Middlesborough, Eng. On the progress during recent years, its causes, the use of generator gas and its cost. 2600 w. Ir Trd Rev—April 20, 1899. No. 27107.

Gasoline Engines.

Economy in Small Power. A comparison between steam and gasoline engines from the user's standpoint. 2800 w. Ir Age—April 6, 1899. No. 26937.

Internal Combustion.

The Use, Care and Repair of Internal Combustion Motors. James W. Tygard. Calls attention to the fundamental differences between gas and steam engines, the ignition, starting, etc. 2500 w. Horseless Age, April 12, 1899. No. 27017.

Vehicle Motors.

See Automobilism.

Windmills.

Improvements and Theories in Wind Motors. (Neuerungen und Theorien über Windmotoren.) R. Friedlaender. With curves showing the relation between velocity and capacity and especial data from the performance of the pumping plant at Heiligenstadt. 4000 w. Mett d Ver f d Ford d Local u Strassen-balmwesens—March, 1899. No. 27273 D.

STEAM ENGINEERING.

Allen Valve.

The Allen Valve for Locomotives. C. H. Quereau. Presents the objections and advantages of this double-ported valve. 2200 w. Trans Am. Soc of Mech Engs—May, 1899. No. 27197 D.

Boiler Explosions.

Investigations of Boiler Explosions. Gus C. Henning. Discusses the fundamental causes of explosions, showing that careful testing and inspection will always be sufficient to demonstrate the cause of any boiler explosion. 2000 w. Trans Am Soc of Mech Engs—May, 1899. No. 27195 D.

Boilers.

Practical Experience on the Strength of Boilers. C. E. Stromeyer. Abstract of a paper read before the British Inst. of Naval Arch'ts. Analyses results obtained and considers general practice in land boilers as compared with Lloyds rules. 2500 w. Engs Gaz—April, 1899. No. 26994 A.

Boiler Trials.

Report of the Committee on the Revision of the Society Code of 1885, Relative to a Standard Method of Conducting Steam Boiler Trials. A copy of the revised code, the changes being chiefly in the line of amendments which experience has shown to be desirable. Ill. 36500 w. Trans Am Soc of Mech Engs—May, 1899 No. 27185 D.

Calorimetry.

Calorimetric Experiments at the Magdeburg Boiler Testing Laboratory. (Kalorimetrische Ergebnisse aus dem Laboratorum des Magdeburger Vereines für Dampfkesselbetrieb.) L. C. Wolff. With tabulated results of tests of the calorific power of a large number of coals and an account of the trials; the Krökerbomb was used. 3000 w. Zeitschr d Ver Deutscher Ing—March 25, 1899. No. 27205 D.

Coal Tests.

See Mining and Metallurgy, Coal.

Condensing.

Central Steam Condensing Plants. From *Stahl und Eisen.* Illustrates and

describes a plant and apparatus for the condensing of the exhaust steam from various engines. 3800 w. Ir Age—April 20, 1899. No. 27102.

Design.

High Speed Engine Design. Practical hints relating to the design of the ordinary double-acting engine of the vertical inverted cylinder type. Ill. 1300 w. Mech Wld—March 24, 1899. Serial. 1st part. No. 26851 A.

Efficiency.

Boiler and Furnace Efficiency. R. S. Hale. Considers the means of determining boiler efficiency and its dependence on the efficiency of combustion and air supply. Tabulated results of tests are given. 6500 w. Trans Am Soc of Mech Engs—May, 1899. No. 27198 D.

Feed Waters.

The Scientific Treatment of Boiler Feed Waters. J. H. Parsons. On the trouble arising from imperfect samples sent for analysis, and the failures due to the steam-users, with report of some of the worst varieties sent for analysis during the past few months. 1400 w. Eng & Min Jour—April 15, 1899. No. 27050.

Governors.

Notes on Shaft Governors. W. B. M'Lean. Deals with practical points in the design of these appliances, noticed by the writer during work connected with high-speed engines which were thus governed. Ill. 2500 w. Can Engr—April, 1899. No. 26970.

High-Pressures.

Effects of High Pressure Steam on Engine Cylinders. F. W. Roller. Reports the successful method of dispensing with lubricants in engines of the vertical type. 1300 w. Am Elect'n—April, 1899. No. 26956.

Jacketing.

A Study of the Function of the Steam Jacket. (Etude du Role de l'Enveloppe de Vapeur.) M. Lefer. A critical analysis of the influence of the jacket on steam economy under various conditions, with indicator diagrams. 6000 w. Bull de la Soc d'Encour—March, 1899. No. 27-230 G.

Naval Boilers.

The Naval Boiler of the Future. Considers what ought to be the characteristics of the ruling type, and how far any one of several boilers is likely to comply with these conditions. 2500 w. Engr. Lond—April 14, 1899. Serial. 1st part. No. 27168 A.

Separator.

Test of a Steam Separator. F. L. Emory. Record of a test of a baffle-plate pattern separator designed to serve as a live-steam separator, as an exhaust-steam separator or trap, and as an oil extractor. 1300 w. Trans Am Soc of Mech Engs—May, 1899. No. 27192 D.

Specifications.

Engine Specifications. An editorial on the proper method of calling for tenders for an engine plant where special machinery is not wanted. 1600 w. Eng Rec—April 1, 1899. No. 26879.

Engine Specifications. Letters from R. H. Thurston and W. H. Bryan on the best method of writing specifications for engines without special features which are to be installed for private parties. 2500 w. Eng Rec—April 15, 1899. No. 27044.

Steam Economy.

The Dependence of Economy Upon Load in Steam Engines. (In Welcher Weise ändert sich mit der Belastung der Dampfverbranch einer Dampfmaschine?) E. Meyer. A careful study of steam economy, comparing load curves and steam consumption, with a mathematical analysis of their relation. 2500 w. Zeitschr d Ver Deutscher Ing—April 8, 1899. No. 27208 D.

Steam Engines.

The Steam Engine. A. Selwyn Brown. Part first considers various rotary engines of recent invention. Ill. 1800 w. Aust Min Stand—March 9, 1899. Serial. 1st part. No. 27008 B.

Steam Pipes.

Steam Pipes. J. T. Milton. Full abstract of a paper read before the British Inst. of Naval Archts. Considers the materials used, their design, the conditions in actual use, etc. Ill. 5000 w. Engs Gaz—April, 1899. No. 26992 A.

Steam Piping. Review of a paper by J. T. Milton before the Inst. of Nav. Archts, with discussion. 2300 w. Eng Rec—April 15, 1899. No. 27045.

Superheating.

Recent Practice in Steam Superheating. Illustrates and describes a new apparatus for superheating steam, giving records of tests and editorial on progress made in Europe, and the interest aroused in the United States. 4200 w. Eng News—April 6, 1899. No. 26944.

Valves.

A New System of Valves for Steam Engines, Air Engines and Compressors. Fred W. Gordon. Illustrates and outlines a system of valves showing their adaptability to shaft governed or automatic vibrating engines. 3500 w. Trans Am Soc of Mech Engs—May, 1899. No. 27189 D.

MISCELLANY.

Inclined Planes.

A Graphical Treatment of the Problem of the Rough Inclined Plane. G. A. Burls. Three cases are considered. 800 w. Engng—April 14, 1899. No. 27166 A.

Liquid Air.

Liquid Air and Its Phenomena. W. C. Peckham. Illustrates and describes experiments with liquid air and apparatus used in compressing. Methods of measuring low temperatures are described. 4200 w. Sci Am Sup—April 27, 1899. No. 27320.

Liquid Air and Low Temperatures. W. H. Swenarton. Reviews the methods of producing low temperatures, and the attempts made to liquefy gases, giving experiments made with liquid air. 2700 w. Yale Sci M—April, 1899. No. 27-104 C.

Liquid Air as a New Source of Power —Another Engineering Fallacy. Henry Morton. A criticism of an article in the March number of *McClure's Magazine*, showing the statements made to be impossible and misleading. 1800 w. Stevens Ind—April, 1899. No. 27122 D.

On the Liquefaction of Air by Dynamical Action. J. E. Denton. Experimental study. Ill. 2200 w. Stevens Ind —April, 1899. No. 27123 D.

The Possibilities of Liquid Air. Elihu Thomson. An exhaustive discussion by a leading authority, of the problems connected with the manufacture, cost, utilization, and mechanical value of liquid air, from the standpoint of the engineer. 4000 w. Engineering Magazine—May, 1899. No. 27281 B.

Paris Exposition.

American Exhibits at the Paris Exposition. A statement of the importance of a good display from the United States, and an explanation of the arrangement of exhibits and of the jury system. 1500 w Eng Rec—April 15, 1899. No. 27034.

MINING AND METALLURGY

COAL AND COKE.

Coal-Cutters.

Two Types of Electrical Coal-Cutters. Thomas H. Barr. From a paper read before the Min. Inst. of Scotland. Describes the Hurd coal-cutting machine and the Clarke electric coal-cutting machine. 1600 w. Col Guard—April 14, 1899. No. 27160 A.

Coal Tests.

Comparative Tests of Bituminous Steam Coals. John W. Hill. A full account of experimental investigations carried on at Cincinnati, in 1897-98, with results. Ill. 14000 w. Pro Am Soc Civ Engs—April, 1899. No. 27304 E.

Colliery Accounts.

The Application of the Double-Account System to Colleries. George Johnson. Gives an illustration of colliery accounts drawn up on the single and double account systems, with comments. 1200 w. Col Guard—April 7, 1899. No. 27089 A.

Culm.

The Accumulations of Culm in the Coal Regions and Their Utilization for Power Purposes. Harry N. Gardner. Showing that progress in furnaces and grates has made it possible to burn much of this culm with profit. Ill. 1400 w. Am. Elect'n—April, 1899. No. 26955.

The Yield of the Reynolds Anthracite Culm Bank. A. De W. Smith. Illustrates the washery at Plymouth, Pa., giving results of the production. 600 w. Eng & Min Jour—April 15, 1899. No. 27048.

Cumberland Region.

Georges Creek—Cumberland Coal Region. Beverley S. Randolph. Describes the geological peculiarities, the qualities of coal, and methods of working. Ill. 2000 w. Mines & Min—April, 1899. No. 26916 C.

Occluded Gases.

The Gases Occluded in Hard Coal. (Ueber die in Steinkohlen Eingeschlossenen Gase.) Dr. Broockman. A review of the various investigations which have been made, together with analyses, and a discussion of the relation of occluded gases to coal-dust explosions. 2500 w. Glückauf—April 1, 1899. No. 27260 B.

Russia.

Notes of a Trip in the North-western Portion of the Basin of the Donez. (Mitteilungen von einem Ausfluge nach dem Nordwestlichen Teile des Donez-Beckens.) G. Franke. An excellent account of this important coal field of Southern Russia, with geological map. 5000 w. 1 plate. Glückauf—March 18, 1899. No. 27259 B.

COPPER.

Auriferous Copper.

The Sampling of Argentiferous and

Auriferous Copper. Albert R. Ledoux. Read at meeting of the Can. Min. Inst. Describes the three methods now in use; boring, taking dip samples and by sawing. Ill. 3000 w. Can Min Rev—March 31, 1899. No. 26899 B.

California.

Copper Resources of California. Herbert Lang. Part first gives an account of the Iron Mountain mine of Shasta County. 2000 w. Eng & Min Jour—April 15, 1899. Serial. 1st part. No. 27049.

Paradox Valley.

The Great Paradox Region. A. B. Frenzel. A description of this valley, the copper mines, etc. 2500 w. Ores & Metals—March, 1899. No. 26878.

Production.

Copper Production and Prices. Discusses the production, consumption, available supply and conditions that have affected prices. 2200 w. Engng—March 24, 1899. No. 26867 A.

GOLD AND SILVER.

Chlorination Plant.

The Utica Mine Chlorination Plant. Thomas N. Smith. Illustrates and describes this California plant, giving itemized statement of cost. 1000 w. Eng & Min Jour—April 22, 1899. No. 27116.

Coinage.

"The Trial of the Pyx," or the Proceedings of the Assay Commission for Testing the Weight and Fineness of the U. S. Coinage. A history of the ancient custom and a description of the methods of sampling and assaying which are now practiced in the United States. Ill. 3300 w. Mines & Min—April, 1899. No. 26913 C.

Cyanide.

The Netto Process for the Treatment of Gold and Silver Ores. (Le Procédé Max Netto pour le Traitement des Minerais d'Or et d'Argent.) L. Legrand. A description of a modified cyanide process as used at the mines at Horcajo, Spain. 3000 w. Rev Univ des Mines—Feb., 1899. No. 27251 G.

Drift Mine.

The Magalia, Cal., Drift Mine. A. D. Gassaway. An account of the discovery, the channel, methods of working gravel, timbering, etc., with illustrations. 3200 w. Min & Sci Pr—April 8, 1899. Serial. 1st part. No. 27032.

Milling.

The German Gold Milling System. F. Hille. Advantages claimed for it over the methods generally employed in the United States. Ill. 1400 w. Mod Mach —April, 1899. Serial. 1st part. No. 26896.

Nova Scotia.

On the Gold Measures of Nova Scotia and Deep Mining. E. R. Faribault. Descriptive account of the geological changes and their results, giving the present features. 4000 w. Can Min Rev—March 31, 1899. No. 26900 B.

Placers.

Dry Gold Placers of the Arid Regions. George H. Stone. The difference in the methods by which they and the wet placers were deposited and the reasons for the failure of so many dry placer machines. 3700 w. Mines & Min—April, 1899. No. 26914 C.

Precipitation.

The Chemical Precipitation of Gold. P. de Wilde. A reply to the discussion on the writer's process of gold extraction, and also a paper by William Bettel, replying to the paper given. 6300 w. Jour of Chem & Met Soc of S Africa—Feb., 1899. No. 27147 E.

Production.

Gold and Silver Production. Reviews the production of the last few years in various parts of the world. 2000 w. Engr, Lond—April 14, 1899. No. 27169 A.

Slimes.

The Lixiviation of Slimes. Alfred James. Compares the results obtained at Kalgoorlie with those of the Witwatersrand. 1100 w. Eng & Min Jour—April 1, 1899. No. 26907.

Smelters.

Smelter and Other Trusts. W. C. Wynkoop. Remarks on the former effort to establish a trust, on the effect on labor and industry, and on trusts in general. 1500 w. Ores & Metals—March, 1899. No. 26877.

Sultana Lode.

Description of the Sultana Quartz Lode and the Sinking of the Burley Shaft in Bald Indian Bay, Lake of the Woods. J. Burley Smith. Ill. 2300 w. Can Min Rev—March 31, 1899. No. 26898 B.

Veins.

Some Characteristic Features of Veins in Granite in California. W. H. S. Describes a peculiar gold-bearing vein formation. 2800 w. Min & Sci Pr—April 22, 1899. No. 27329.

West Kootenay.

West Kootenay Ore Bodies. R. W. Brock. Read at meeting of the Canadian Min. Inst. Briefly reviews facts relating to the geology so far as it is connected with the ore deposits, and the ore de-

posits themselves. 5500 w. Can Min Rev —March 31, 1899. No. 26897 B.

Wyoming.

The Mineral Belt of the Sierra Madre Range of Mountains in Southern Wyoming. E. P. Snow. The location, discovery, development and account of the principal mines. Ill. 2400 w. Min Rept—April 6, 1899. No. 27092.

IRON AND STEEL.

Chemistry.

See Mechanical Engineering, Foundries.

Concentration.

The Magnetic Concentration of Iron Ores. (Magnetische Aureicherung von Eisenerzen.) Dr. Leo. A description of the Gröndal-Dellwik process of magnetisation and magnetic concentration as operated at Pitkäranta in Finland. 1500 w. Stahl und Eisen—March 15, 1899. No. 27255 D.

Hot Blast.

The Equalization of the Temperature of Heated Gases. (Verfahren Zum Ausgleichen der Temperatur Heisser Gase.) An illustrated description of the Gjers and Harrison arrangement of hot-blast stoves by which the fluctuations in temperature are avoided. 1200 w. Stahl und Eisen—March 15, 1899. No. 27256 D.

Lake Superior.

Methods of Mining Iron Ore in the Lake Superior Region. Nelson P. Hulst. Descriptions of the methods used, with illustrations. 10500 w. Pro of Eng's Soc of W. Penn—Feb., 1899. No. 27100 D.

Magnetic Deposits.

The Use of Magnetic Instruments for Discovering Magnetic Ore Deposits. G. Nordenstrom. On the use of these instruments in Sweden, showing the advantages and usefulness to be beyond question. Ill. 2000 w. Ir Age—April 13, 1899. No. 27007.

Oxygen.

The Combined Oxygen in Steel. (Ueber den Sauerstoffgehalt des Stahls.) A. Ledebur. A discussion of the influence of combined oxygen, and of the best methods of determining the amount present. 3000 w. Stahl und Eisen—March 15, 1899. No. 27254 D.

Steel.

Influence of Arsenic on the Mechanical Properties of Steel. M. J. Marchal. Extract from the Bulletin de la Société d'Encouragement. Reports a series of experimental tests, concluding that steel otherwise pure will not suffer by the presence of such amounts of arsenic as are occasionally found, though defects due to other impurities may be increased by its presence. 800 w. Ir Age—April 13, 1899. No. 27006

MINING.

Air-Shafts.

Upcast Air Shaft Fitted for Winding with 12-Decked Cages. M. Ghysen. From a communication to the Liége Engs' Assn. Describes the conditions which led to the use of 12-decked cages, and their use and movement. Ill. 2600 w. Col Guard—April 14, 1899. No. 27159 A.

Cavilling.

The Cavilling System. M. I. M. E. An explanation of this system and a discussion of whether it pays. 4000 w. Col Guard—March 30, 1899. No. 27003 A.

Electric Power.

Electricity in Mining. William Maurice. Abstract of a paper read before the Chesterfield and Midland Counties Inst. Part first deals with electric blasting, mainly in its connection with coal mining. 2200 w. Aust Min Stand—March 9, 1899. Serial. 1st part. No. 27009 B.

Explosives.

The Theory of Safety Explosives. From a communication by Bergassessor Heise to *Gluckauf*. Discusses the conclusions reached by the Prussian Firedamp Commission, and the French investigators, and gives the opinions of the writer. 3300 w. Col Guard—April 14, 1899. No. 27161 A.

Lamp.

Improved Form of Sussman Lamp for Belgian Collieries. From a communication of M. A. Abrassart, to the Société des Ingenieure Sortis de l'Ecole des Mines du Hainaut. Illustrates and describes the improvements, and states the advantages and disadvantages. 2400 w. Col Guard—March 30, 1899. No. 27004 A.

Mine Timber.

Mine Timber, its Choice and Preservation. Arthur Lakes. Reviews the various timbers used, mentioning some curious kinds the use of which is necessitated in high and arid regions. Also considers methods of preservation. Ill. 1700 w. Mines & Min—April, 1899. No. 26917 C.

Mining Laws.

Chamber of Mines, N. S. W. Suggestions for the amendment of mining laws submitted to the Minister for Mines. 2200 w. Aust Min Stand—Feb. 25, 1899. No. 26841 B.

Lodes vs. Placers. F. T. Freeland. Discusses an opinion rendered by Justice Goddard in the Supreme Court of Colorado, and also other decisions. 900 w.

Eng & Min Jour—April 1, 1899. No. 26908.

Pumps.

Care of Mining Pumps. George D. Rice. Considers the various things that cause trouble and means of remedying them. 1800 w. Min Rept—April 13, 1899. No. 27094.

Pumping Plant at Houghhead Colliery. Illustrates and describes a plant recently erected near Glasgow, and the trial. 1200 w. Engr, Lond—April 7, 1899. No. 27086 A.

See Mechanical Engineering, Hydraulics.

Rescue Appliances.

Rescue Appliances in Mines. G. A. Meyer. From a lecture delivered before the Verein der Technischen Grubenbeamten at Herne. Illustrates and describes the system in use at Shamrock Colliery. 3400 w. Ir & Coal Trds Rev—April 14, 1899. No. 27174 A.

Shafts.

Means for Preventing Accident in Mine Shafts. Victor Watteyne. From a communication to the *Annales les Mines de Belgique*. Deals with accidents in connection with winding, and with air and pumping shafts, also at landings. 5000 w. Col Guard—March 24, 1899. Serial. 1st part. No. 26876 A.

Shaft-Sinking.

The Sinking of Shafts No. 5, 6 and 7, at the Bascoup Colliery, Belgium. (Enfoncements des Puits No. 5, 6 et 7, du Charbonnage de Bascoup.) E. Briart. Especially devoted to the methods used in sinking through watery strata of sand, and layers of clay, by the use of metallic tubing. 3500 w. 1 plate. Rev Univ des Mines—March, 1899. No. 27253 G.

Ventilators.

Compression Ventilators in German Coal Mines. From *Zeitschrift fur Berg-Hutten-und Salien Wessen*. Translation of paper by Bergassessor Steinhoff. Illustrated description of the system, with statement of its advantages. 1800 w. Eng & Min Jour—April 8, 1898. No. 26985.

MISCELLANY.

Aluminum.

The Properties and Applications of Aluminum. (Sur les Propriétés et les Applications de l'Aluminum.) A. Ditte. Particularly devoted to the durability of the utensils used by the French soldiers in Madagascar, and indicating the metal to be less adapted for such purposes than has been supposed. 3000 w. Comptes Rendus—March 27, 1899. No. 27245 D.

Charleroi.

A Tour in the Charleroi District, Belgium. (Excursions dans le Bassin de Charleroi.) M. J. Smeysters. An account of the visit of a party of engineers to the various mining and metallurgical establishments in the district about Charleroi, Belgium, with much information of interest. 10,000 w. 3 plates. Rev Univ des Mines—Jan, 1899. No. 27250 G.

Clay.

Clay Mining. E. Lovejoy. A description of the methods employed in mining clay by the Columbus Brick and Terra Cotta Co., at Union Furnace, O. 1600 w. Mines & Min—April, 1899. No. 26912 C.

Cornwall.

Crushing and Concentration at Dolcoath Mine, Cornwall. R. Arthur Thomas. Notes the changes which gradually led to the introduction of automatic machinery, and the economy secured. 2000 w. Col Guard—April 14, 1899. No. 27162 A.

Fuel Gas.

See Gas Engineering.

Manganese.

Some Sources of Manganese Ore Supply. An account of the deposits in the Caucasus, Brazil, and Cuba, with the characteristics, methods of treating, cost of production, transportation, etc. 4800 w. Ir & Coal Trds Rev—April 7, 1899. No. 27088 A.

Mineral Resources.

Mineral Resources of the Antilles, Hawaii, and the Philippines. David T. Day. A review by the chief of the Statistical Division of the U. S. Geological Survey, of the mineral resources of these islands, giving a resumé of the latest official information. 4000 w. Engineering Magazine—May, 1899. No. 27285 B.

Onyx.

The Kentucky Onyx Fields. S. S. Sorby. A description of the formation of onyx with illustrated account of the deposits named, and general remarks. 1700 w. Am Mfr & Ir Wld—March 31, 1899. No. 26906.

Ores.

The Genesis of the Deposition of the Ores of Metals in the Earthcrust. Carl Wulsten. Gives the writer's views, based on 40 years of observation, study and work. 1800 w. Min Rept—April 6, 1899. No. 27093.

Quicksilver.

Quicksilver Reduction at New Almaden Mines, California. Arthur Lakes. A description of some of the furnaces formerly used and those at present employed for reducing both fine and coarse

ores. Ill. 4000 w. Mines & Min—April, 1899. No. 26915 C.

Rock Salt.

Rock Salt Mining at Heilbronn. (Mittheilungen über den Steinsalz-Bergban in Heilbronn.) Alexander Iwan. A general description of the geological conditions, and of the mechanical methods employed. Two articles. 5000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 18, 25, 1899. No. 27258 each B.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Fatal Accidents to Trainmen in 1893 and 1897. Editorial showing that the annual report of the Interstate Commerce Commission may show a possible error in the statistics. 1400 w. R R Gaz—April 14, 1899. No. 27029.

Train Accidents in the United States in February. Detailed list and classified summary. 4500 w. R R Gaz—April 14, 1899. No. 27030.

Speed.

Speed of Express Trains in France. A free translation of an article by Mr. Varennes which appeared about three years ago, covering the period from 1854 to 1895 inclusive. 2700 w. R. R. Gaz—April 7, 1899. No. 26948.

Trains Parting.

The Cause of Trains Parting and the Best Methods of Preventing Same. Extracts from a paper prepared by a committee of members of the Assn. of R. R. Air Brake Men, with comments. 2000 w. Ry & Engng Rev—April 22, 1899. No. 27178.

Train Rules.

Revised English Train Rules. Considers some of the rules which are of special interest to this country. 2100 w. R R Gaz—April 14, 1899. No. 27027.

The Standard Code of Train Rules of the American Railway Association for Single Track. A copy of the rules adopted at Detroit, April 12, 1899. 5200 w. R R Gaz—April 21, 1899. No. 27115.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

A New Device for Preventing the Sliding of Car Wheels by Air Brakes. Illustrates and describes a device, designed for use in connection with the ordinary air brake, which is being tried on the Pacific coast. 800 w. Eng News—April 20, 1899. No 27111.

Car Repairs.

Additional Compensation for Car Repairs Done West of the 105th Meridian. J. H. Goodyear. Discussing the schedule of prices and the allowing of a differential charge to give relief to roads making repairs at a loss. 2700 w. R R Car Journal, April, 1899. No. 26989.

Cars.

Light and Heavy Cars. O. H. Reynolds. Discussion showing the effect of the heavy car on the revenue of railways. Ill. 3300 w. Am Eng & R R Jour—April, 1899. No. 26902 C.

Car Wheels.

See Mechanical Engineering, Machine Works.

Corridor Car.

Corridor Cars of the Eastern Railway of France. (Les Wagons à Intercirculation de la Compagnie de l'Est). D. Bellet. Illustrated description of these new railway carriages; a corridor along one side enables circulation to be made through the train without passing through the compartments. 2000 w. 1 plate. Revue Technique—April 10, 1899. No. 27218 D.

Couplers.

The Automatic Couplers Bill. A statement of the case against the coupler section of the Regulation of Railways Bill, in England. Ill. 3500 w. Transport—March 17, 1899. No. 26848 A.

Dynamometer.

The Teodorovitch Dynamometric Apparatus. (Appareil Dynamometrique de M. Teodorovitch.) H. Chevalier. An illustrated description of an improved dynamometer for the measurement of train resistance, as used on the Kharkow-Nicolaiew Railway, Russia. 2500 w. Soc Ing Civ de France—Jan. 1899. No. 27234 G.

Fireboxes.

Tests on Wide and Narrow Fireboxes. H. H. Vaughn. Illustrated account of the tests made by the Philadelphia & Reading Railway. 1800 w. Am Eng & R R Jour—April, 1899. No. 26901 C.

Gondola Car

80,000-Pounds Capacity Gondola Car for the Lake Shore and Michigan Southern Railway. Engravings showing the

principal features, with brief description. 800 w. R R Gaz—April 28, 1899. No. 27333.

Lavatory Carriage.

Lavatory Carriage, London and South Western Railway Co. Illustrates and describes a car recently built for service on this line, which combines peculiarities of the American and English practice. 2300 w. R R Car Jour—April, 1899. No. 26990.

Locomotives.

A Link in Early Locomotive History. The share taken in the development by the firm of Messrs. Mather, Dixon & Co., of Liverpool. 1800 w. Engr, Lond—April 14, 1899. No. 27170 A.

A Once Famous Locomotive. Charles Rous-Marten. An account of the runs of engine 123, of the Caledonian Railway, with its history and recent trial. 3200 w. Engr, Lond—March 31, 1899. No. 26972 A.

A. Rogers' 10-Wheeler for the Great Northern. Engraving and descriptive specifications. 2500 w. R R Gaz—April 28, 1899. No. 27337.

A Schenectady 8-Wheeler for the Vandalia Line. Illustration with dimensions. 600 w. R R Gaz—April 28, 1899. No. 27336.

Compound Locomotives on the Northern Pacific Ry. Edwin M. Herr. Abstract of a paper read before the Western R'y Club. An interesting account of the different systems of compounding employed, and the types and other particulars. 3800 w. Eng News—April 27, 1899. No. 27339.

Compound Locomotives on the N. P. R'y. Data from the paper of E. M. Herr, presented at the March meeting of the Western Ry. Club. 2000 w. Ry & Engng Rev—April 22, 1899. No. 27175.

Heavy Consolidation Locomotive for the Cleveland, Cincinnati, Chicago & St. Louis Railway. Illustrated description with principal dimensions of the largest locomotive so far built for this road. 700 w. R R Gaz—April 28, 1899. No. 27335.

Running a Vauclain Compound. C. G. Herman. Describes what the writer considers the best method of handling this type of locomotive. 1600 w. Loc Engng—April, 1899. No. 26854 C.

Six-Coupled Compound Express Engine. Illustrates and describes a new type lately put into service on the Austrian State Railways. 700 w. Engr, Lond—March 31, 1899. No. 26976 A.

The Development of the Four-Cylinder Compound. Statement made by R. H. Soule, at meeting of the Western Railway Club, of the changes which have been made in the four-cylinder compound. 700 w. R R Gaz—April 28, 1899. No. 27334.

The Movements in Locomotives and their Influence upon the Rails. (Die Eigenbewegungen der Lokomotiven und Ihre Einwirkung auf die Gleise.) H. von Borries. A paper before the German Railway Society showing the influence of the internal motions of a locomotive upon the rails; with discussion. 3500 w. Glaser's Annalen—April 1, 1899. No. 27248 D.

Resistance.

Resistance of Empty and Loaded Coal Cars. Gives the results thus far obtained in investigations. 1000 w. R R Gaz—April 14, 1899. No. 27028.

Side Rods.

Cast Steel Side Rods. Illustrates and describes the practice of the Philadelphia & Reading, as applied to consolidation engines. 500 w. Am Engr & R R Jour—April, 1899. No. 26903 C.

Testing Locomotive.

The New Testing Locomotive at Columbia University. Herbert T. Wade. Illustrated description of the full size passenger locomotive, the gift of the Baldwin Locomotive Works, of Philadelphia. 1300 w. Sci Am—April 15, 1899. No. 27015.

Valve Gear.

A Special Valve Gear. (Une Distribution Speciale.) M. F. Panoux. A description with valve diagrams, of a locomotive cut-off valve gear used on the Northern Railway of Spain. The cut-off valve, riding on the main slide valve, is operated from a point on the link. 2500 w. 1 plate. Rev Gen des Chemins de Fer—April, 1899. No. 27233 F.

Vestibules.

See Street and Electric Tramways.

NEW PROJECTS.

Africa.

The Cape to Cairo Railroad. H. G. Prout. Extracts from an article in Munsey's Magazine for April, giving information concerning this project, its cost, and other means of attaining the same ends at less expense. 1200 w. R R Gaz—April 14, 1899. No. 27025.

Colorado.

Notes on Colorado Railways. Gives interesting profiles, sketch map and illustrations, with particulars of various lines. 3500 w. Eng News—April 6, 1899. No. 26943.

Far East.

Railway Connection Between Burma and China. Editorial on the paper of Dr. John Nisbet, recently read before the Society of Arts. 2800 w. Engng—April 7, 1899. No. 27078 A.

Japan.

Railways in Japan. An account of the railway development, the supervision by

the Government, the individual lines and general results. Map. 2500 w. Engng—April 14, 1899. No. 27163 A.

Mountain Railway.

The Electrically-Driven Mountain Rope Railway at Mont-Dore. Translation of an article in *Elektrotechnische Zeitschrift*. Describes a railway said to be the only example of its kind in Europe. 1530 w. Elec Eng, Lond—March 31, 1899. No. 26996 A.

The Nilgiri Mountain Railway. An illustrated account of this Indian railway and its equipment. 1100 w. Engr, Lond—March 31, 1899. No. 26974 A

Railway Location.

Rules for Railway Location and Construction; Northern Pacific Ry. Extracts from the rules and instructions for the engineering and construction departments, with editorial comment. 11400 w. Eng News—April 20, 1899. No. 27113.

Russia.

The White Sea Railway. A brief account of this project and the advantages it will bring to Russia and Finland. 900 w. Engr, Lond—April 7, 1899. No. 27084 A.

Trans-Siberian.

The Trans-Siberian Railway. Details concerning the state of the work, taken from the official report. 1600 w. Engr, Lond—April 7, 1899. No. 27083 A.

Yukon Railway.

Opening the White Pass and Yukon Railway. W. M. Sheffield. Information concerning this great engineering feat, and the portion of the road already constructed. Ill. 1200 w. Sci Am—April 15, 1899. No. 27012.

PERMANENT WAY AND FIXTURES.

Boston Station.

I. The Planning and Building of the Southern Station, Boston. George B. Francis. II. The Mechanical Equipment of the Southern Station. Henry J. Conant. An illustrated account of this large project and its many details is given in the first paper, while the second gives an illustrated description of the mechanical equipment, exclusive of track and structural work, which cost nearly three-quarters of a million dollars. 8400 w. Tech Quar—March, 1899. No. 27021 E.

Coaling Station.

The Jersey City Coaling Station of the Erie Railroad. Illustrated description of a plant that has proved efficient and economical. 1600 w. R R Gaz—April 14, 1899. No. 27026.

Curves.

The Determination of Elevation and Spread of Rails on Curves. (Zur Bestimmung der Ueberhöhungen und Erweterungen in Eisenbahn-curven). Emil Masik. A very full discussion of the questions of the elevation of the outer rail and the proper spread for various curves and speeds. Two papers, 8000 w. Zeitschr d Oesterr Ing v Arck Ver—March 31, April 7, 1899. No. 27210 each B.

Grade Crossings.

Proposed Abolition of Grade Crossings at Syracuse. An abstract of the report of Henry B. Seaman to the city government giving plans for a comprehensive treatment of the problem. 1600 w. R R Gaz—April 21, 1899. No. 27114.

Narrow Gauge.

Narrow Gauge Railways. F. J. E. Spring. Describes the Darjeeling-Himalayan railway, the Howrah-Amta and Howrah Sheakhalla tramways, the Barsi light railway and the Tezpur tramway. 3500 w. Ind & East Engr—Feb., 1899. No. 26850 D.

Railroad Bridge.

See Civil Engineering, Bridges.

Railroad Ties.

The Artificial Preservation of Railroad Ties by the Use of Zinc Chloride. Walter W. Curtis. A review of knowledge on this subject and a report of the critic's investigations. 2000 w. Pro Am Soc Civ Engs—April, 1899. No. 27305 E.

Road Bed.

Permanent Way Construction in Tunnels. (Le Mode de Pose de la Voie des Chemins de Fer dan les Souterrains). J. Michel. An argument against the use of ballast for underground roads or in tunnels, and a recommendation of stringers laid in concrete. 3500 w. Rev Gen des Chemins de Fer.—April, 1899. No. 27232 F.

Signals.

A Code of Positive Signals. Editorial discussion of the difficulties, and of the changes recently made by the officials of the N. Y., N. H., & H. R. R. 1800 w Loc Engng—April, 1899. No. 26855 C.

Block Signaling on the Atchison, Topeka & Santa Fe Railway. Describes the system of this road which has about one-fifth of its line operated on this plan. 1300 w. Eng News—March 30, 1899. No. 26863.

Electric Signal Systems for Railways. (Ueber Elektrische Signalisirung der Gleiswege.) A paper by Director Othegraven before the German Railway Society, discussing especially signalling in

terminal stations and yards. 2500 w. Glaser's Annalen—April 1, 1899. No. 27-249 D.

Yellow as a Color for Distant Signals. N. Y., N. H. & H. R. R. Discusses the need of a third color and the study that has been given the problem, with the decision of the road named. 1600 w. Am Engr & R R Jour—April, 1899. No. 26904 C.

Station Grounds.

Landscape Gardening on the Boston & Albany. Ellen F. Blodgett. An account of the artistic work which has so greatly added to the beauty of the route. 800 w. R R Gaz—April 7, 1899. No. 26947.

TRAFFIC.

Bicycles.

Bicycle Traffic on the Long Island Railroad. Illustrated detailed description of methods used by this road, which carried over 176,000 wheels in six months. 1300 w. R R Gaz—April 7, 1899. No. 26949.

STREET AND ELECTRIC TRAMWAYS

Algiers.

Electric Railway in Algiers. Illustrated description of a line operated by a French Company, connecting Algiers with neighboring towns. 1800 w. St Ry Jour—April, 1899. No. 26921 D.

Boston Elevated.

The Central Power Station of the Boston Elevated Railway. H. W. Weller. Brief historical sketch and detailed description of the arrangement and equipment of this station. 4500 w. Ry Wld—April 13, 1899. No. 27330 A.

Carriage Works.

The Electric Railway and Tramway Carriage Works. Illustrated detailed description of the new factory at Preston, England, and the course of car construction, power distribution, etc. 2300 w. Ry Wld—April 13, 1899. No. 27-332 A.

Preston Works.

See Mechanical Engineering, Machine Works.

Rapid Transit.

Expert Opinion of the New Rapid Transit Proposition in New York. Letter from Stuyvesant Fish, president of the Illinois Central, containing valuable suggestions based on experience. 2800 w. St Ry Jour—April, 1899. No. 26-920 D.

Rapid Transit in Dense Centers of Population. John Lundie. On the problem in New York, and the importance of speed on elevated roads. 2400 w. St Ry Jour—April, 1899. No. 26923 D.

The Cost of Speed in Rapid Transit Service. J. R. Cravath. An investigation of the relative cost of various schedule speeds under a given set of conditions. 4000 w. Elec Wld & Elec Engr—April 1, 1899. Serial. 1st part. No. 26889.

The New York City Rapid Transit Proposition of the Metropolitan Street Railway Company. A copy of the proposal of the Metropolitan St. Ry. Co., with explanation of the plan, and editorial. 5500 w. St Ry Jour—April, 1899. No. 26924 D.

Repairing.

Steel in Car Repairing. W. H. Glenn. Suggestions relating to repairs and where steel can be substituted advantageously for wood. Ill. 1800 w. St Ry Rev—April 15, 1899. No. 27057 C.

Repair Shops.

See Mechanical Engineering, Machine Works.

Rolling Stock.

Maintenance and Repairs of Rolling Stock. J. W. Greer. Part first is largely introductory and considers the labor account. 1800 w. St Ry Rev—April 15, 1899. Serial. 1st part. No. 27058 C.

Third-Rail System.

A Sectional Third-Rail Electric Street Railway System. Describes the 2000-ft. experimental section of track at Manhattan Beach, of the Murphy Safety Third-Rail System, stating the advantages claimed and the defects. Ill. 1600 w. Eng. News—April 27, 1899. No. 27343.

Three-Phase.

Chicago and Milwaukee Three-Phase Electric Railway. S. S. Sherman. Illustrated detailed description of the new Chicago and Milwaukee line. 4000 w. Elec Wld & Elec Engr—April 8, 1899. No. 26967.

Tramways.

Electric Traction and Its Application to Suburban and Metropolitan Railways.

Philip Dawson. A paper aiming to show the adaptability of this motive power to the rapid transportation of large crowds from and to their business in large cities. 8700 w. Jour Soc of Arts—March 24, 1899. No. 26865 A.

Newcastle Tramway. Full text of the report of W. George Laws on the question of the introduction of electric tramways into that city, and the most desirable system to adopt. 5200 w. Elect'n, Lond—April 14, 1899. No. 27150 A.

The Development of Electric Tramways in the United Kingdom. Reviews the changes and progress, and gives Mr. Parshall's reasons for opposing the combining of lighting and tramway business. 2400 w. St Ry Rev—April 15, 1899. No. 27059 C.

The Relations of Municipalities and Their Street Railways. John W. Boyle. Considers the benefits, the liability for paving from the company's point of view, etc. 3500 w. St Ry Rev—April 15, 1899. No. 27060 C.

Transportation Problems.

Some of the Larger Transportation Problems in Cities. Edward E. Higgins. An explanation of the scheme of modern street railroading and the problems to be solved. 5000 w. Jour Fr Inst—April, 1899. Serial. 1st part. No. 26954 D.

Traveling Platform.

History of the Attempts at Continuous Locomotion. (Historique des Tentatives de la Locomotion par Entrainement Continu.) M. Armengaud. An historical review of the various schemes which have been advanced for a traveling platform, down to the present device adopted for the exposition of 1900. 4500 w. 1 plate. Soc Ing Civ de France—Feb., 1899. No. 27240 G.

Underground.

New Life for the New York Underground Railway. A review of the terms under which the Metropolitan Street Railway Co., of New York, offered to build an underground railway in the city. 1300 w. Eng Rec—April 1, 1899. No. 26883.

Vestibules.

Arguments Against the Vestibuling of Cars. A letter addressed by John W. McNamara to the committee of railroads of the State Assembly of New York, arguing against the passage of bills in relation to the enclosing the platforms of cars of street railways. 1600 w. St Ry Jour—April, 1899. No. 26925 D.

Working Expenses.

Working Expenses of Electric and Cable Railways. Tables giving the working expenses, receipts, etc., of three railways in Great Britain. 1300 w. R Wld—April 13, 1899. No. 27331 A.

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The Brown Hoisting and Conveying Machine Co., Cleveland, O., U. S. A.=A very handsome and elaborately illustrated album of cranes and other hoisting machinery, including locomotive, cantilever and gantry cranes, electric traveling cranes, overhead tramrail and other devices for handling materials.

The National Meter Co., New York.=Catalogue of the Nash gas and gasoline engine, showing numerous applications for general driving as well as for direct-connected electric generators, and for pumping plants. Tables of sizes and capacities are given, and a number of testimonials are appended.

Library Bureau, Boston, Mass., U. S. A.=Classified illustrated catalogue of library supplies, including book stacks, furniture, card indexes, and every variety of material for the equipment of libraries, or for other systematical classification.

Brown & Sharpe Manufacturing Company, Providence, R. I., U. S. A.=Catalogue of Machine tools, gear cutters, standard rules and gauges and small tools. Many valuable tables for use in connection with gear cutting are given, and a number of machines and tools have been added since the issue of 1898.

Bates Machine Company, Joliet, Ill., U. S. A.=Catalogues (a) of the Bates Corliss engines of various designs and sizes; (b) of the Cookson feed-water heaters and receivers; (c) of a great variety of wire and wire-nail machinery; and (d) of a partial list of users of the Bates Corliss engines.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.=Record of Recent Construction, No. 12, being an illustrated pamphlet of locomotives built for use in various parts of the United States, as well as for Brazil, Hawaii, Cuba, Canada and Australia.

Michigan Pipe Company, Bay City, Mich., U. S. A.=Catalogue of creosoted wood tubing treated by the Bethell process, for casings for steam and gas pipes, and for conduits for electrical conductors.

Rochester Machine Tool Works, Rochester, N. Y., U. S. A.=Catalogue of the Acme automatic engines and boilers, for small powers, using oil fuel, or, if preferred, coal or wood. Details of the engines, boilers and atomizers are given, and numerous examples of successful application.

Fitchburg Steam Engine Co., Fitchburg, Mass., U. S. A.=Handsomely illustrated catalogue of the Fitchburg automatic steam engines, both high and low speed, simple and compound, also steam boilers and steam appliances. Details of the cutoff gear are given and an instructive comparison of indicator diagrams.

Hess, Snyder & Co., Massillon, Ohio, U. S. A.=Catalogue of friction clutch pulleys and friction clutch couplings, also plain and split cast iron pulleys, hangers, shafting, boxes, couplings and general machinery of transmission.

Potter & Johnston Co., Pawtucket, R. I., U. S. A.=Pamphlet catalogue of shaping machines, giving illustrations, description and detailed specifications of the 15- and 24-inch machines of modern design built by this firm.

The Mechanical Rubber Co., Chicago, Ill., U. S. A.=Catalogue and price list of rubber belting, hose, packing and a variety of miscellaneous mechanical rubber goods. A special telegraphic code is appended.

Greene, Tweed & Co., New York.=Well printed and illustrated catalogue of the Rochester automatic force feed lubricators, showing applications to various types of steam engines; also numerous testimonials from users.

Meriden Machine Tool Co., Meriden, Conn., U. S. A.=A Story Without Words, being a humorous exposition of the wide range of capacity of the Meriden forming lathe. A number of convenient accessories to the forming lathe are shown.

Ingersoll-Sergeant Drill Company, New York.=Catalogues (a) and index of Ingersoll-Sergeant Rock Drills, consisting of a brief illustrated list of the standard styles of the Ingersoll-Sergeant drills and being supplementary to the complete catalogue, No. 41; and (b) No. 25,000, being a handsome pamphlet commemorative of the completion of the twenty-five thousandth rock drill made by the company.

The John H. McGowan Co., Cincinnati, Ohio, U. S. A.=Booklet No. 25, listing and describing the designs of pumping machinery for which there is current demand, and intended as a guide to further detailed inquiries.

J. B. Colt & Co., New York.=Catalogues (a) of the Criterion Acetylene gas generator; (b) supplementary pamphlets Nos. 57, 60, 111, 120A and 121, describing various forms of the

generator for fixed and portable use, as well as for searchlights and contractors' lighting, together with the record of the underwriters' approval; (c) a pamphlet giving a general description of the properties of acetylene, the method by which it is generated and the numerous applications of which it is capable.

F. Cortez Wilson & Co., Chicago, Ill., U. S. A.=Pamphlets upon acetylene (a) describing the Acetogen, an apparatus for generating acetylene; (b) the acetylene dealers' handbook, containing general information regarding installations of plant, burners, etc.; and (c) a summary of opinions of eminent authorities of Europe and America upon the properties of acetylene, precautions to avoid danger, sound principles of generation, etc.

The Garton-Daniels Electric Company, Keokuk, Iowa, U. S. A.=Catalogue No. 22, describing the improved Garton lightning arresters, with illustrations showing their application in a great variety of cases for electric light, power and railway circuits of any voltage, direct or alternating current.

Anchor Electric Co., Boston, Mass., U. S. A. =Catalogue No. 8 of Anchor switches, push buttons, conduit boxes, sockets, cut-outs and other electrical supplies. A special telegraph code is appended.

D. R. Sperry & Co., Batavia, Ill., U. S. A.= Thirtieth annual price list of sugar kettles, cauldrons, farm boilers, ovens and supplies. Cauldrons as large as 500 gallons' capacity are listed, and various forms and settings are illustrated.

J. Stevens Arms & Tool Co., Chicopee Falls, Mass., U. S. A.=Pamphlet catalogue of calipers, dividers, surface gauges, nippers, protractors and other small tools for machinists' use.

Byram & Company, Detroit, Mich., U. S. A. =Pamphlet catalogues (a) of the Colliau foundry cupolas, with illustrations, lists of sizes and partial list of users, including twenty educational institutions in all parts of the United States; and (b) of Byram's foundry ladles, either hand, buggy or crane, of sizes from 1,000 to 35,000 pounds capacity.

The Carlisle & Finch Co., Cincinnati, Ohio, U. S. A.=Handsome catalogue A of searchlight projectors, adapted for land or marine use. Details of the reflector arrangement and of the special form of arc lamp are given, and illustrations and price lists of the several forms.

The Jeffrey Manufacturing Company, Columbus, Ohio, U. S. A.=Mining department catalogue No. 16, illustrating and describing coal mining machinery operated by electricity and by compressed air. A variety of machines for under-cutting, shearing and drilling are shown, as well as electric locomotives, pumps and other appliances for use in connection with coal mining.

Clayton Air Compressor Works, New York. =Complete catalogue No. 10, filled with handsome illustrations of the various types of Clayton air compressors, adapted to be driven either by steam or belt. Tables of dimensions and capacities are given, and much useful information relating to the production and application of compressed air.

Jenkins Brothers, New York.=Catalogue 1899, of improved Jenkins valves and fittings for steam, water, oils, acids or gases. A great variety of globe, straight-way and angle valves are listed, and a variety of back-pressure valves, check valves and special steam appliances.

Pierce, Butler & Pierce Mfg. Co., Syracuse, N. Y., U. S. A.=Very handsome large catalogue of steam and hot-water boilers for house heating, showing various types adapted for different purposes and forming a most effective presentation of an important line of devices for the purpose.

New York Central and Hudson River Railroad, New York.=Four-Track Series, handsomely illustrated folders, setting forth the attractions of various portions of the country reached by the railroad, including fine maps and instructive descriptive matter. Folder No. 26 contains a reprint of "A Message to Garcia," a little brochure which originally appeared in "The Philistine," and which has been much sought after since the exhaustion of the original edition.